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ANNOUNCEMENTS.

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In consequence of the large number of pages to be prepared and passed for press, the careful nature of the printing required for high-class production, the advance arrangements made for extensive circulation, and in order to facilitate departmental business, observance of the following rules is necessary:—

Literary Matter to reach the offices not later than the 1st of the month (as much earlier as possible) previous to date of publication. Communications to be addressed "Editorial Department."

Advertisements intended for insertion in next issue must be received not later than the 15th of the month (as much earlier as possible), to insure correct classification. All communications respecting same to be marked "Business Department." Advertising Rates, on application, regulated according to positions available.

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ARTICLES BY EXPERTS THAT WILL APPEAR IN THE NEXT AND SUCCEEDING ISSUES OF "FEILDEN'S MAGAZINE."

Electric Fires.
The Federation of Labour Unions.
The Town Refuse Problem.
The Motor Car and its Future.
Heat of Combustion of Hydro-Carbon Gases.
Railway Rolling Stock of High Capacity.
Town Lighting by Electricity.
The Construction of Docks.
Foundry Cupolas.
Modern Fast Cruisers.
High-Speed Steam Engines.
Modern Stone-Working Machinery.
Tea Manufacture, etc., etc.

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THE EDITOR will be pleased to consider Literary Contributions dealing with subjects within the purview of this Magazine, and to make satisfactory arrangements with Contributors if MSS. be accepted for publication. High-class engravings from photos and drawings will be prepared free of cost to the writer.

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The Government and the Navy.

It is not for us to express a judgment on the demerits of the Navy Programme for the current year. That has already been adequately attended to by a multitude of newspaper experts, whose knowledge of the question they determine in most cases appears to be derived from the first book of reference on which they can lay their fingers.

There has been a serious falling off in the estimated naval constructional output from private shipbuilding yards. The fact has been much commented on, seeing that it affords a convenient occasion for the deliverance of safe generalities. Some critics blame the Government, others the contractors; in either case the result is the same. The interest of that subject is soon dissipated by some other topic of discussion and it promptly becomes "stale."

Yet, considering that the new constructional expenditure for the Navy has lagged behind during the past three years, to the extent of £5,343,000, it might be presumed by some that a circumstance of such ominous importance would possess more vitality as a matter for public comment.

Seeing how promptly warships are delivered by their British contractors to foreign navies, contrasted with the delays that have taken place in the completion of the additions to our own, there would appear something to be accounted for beyond the strike of the engineers, which formed the excuse last year, and which has been utilised as a whipping-boy in so many different interests, and on so many different occasions.

Our contemporary, the *Daily Mail*, which seldom expresses itself editorially without having something solid in the background, inferentially crediting the Admiralty with their courage in surrendering an excuse which has been worn out, says, "We are not put off this time with the excuse of the engineering strike, but with the statement that the under-expenditure is to be explained by 'delays in delivery of material, difficulties in securing adequate numbers of workmen, and other circumstances.' We have, however," proceeds the *Daily Mail*, "ourselves heard from shipbuilders a very different story. It is to the effect that during 1899 the Treasury has been withholding payments from the constructors on every kind of frivolous pretence."

Is *that* the reason? Opinions may differ, considering the authority which attaches to the *ipse dixit* of a First Lord. But it is tolerably safe to assume that the *Daily Mail* had both chapter and verse behind it in making such a statement, and in that light the question takes a very serious aspect. Our contemporary states explicitly, "we *have ourselves* heard from shipbuilders a very different story," *i.e.* that they could not get their money from the Treasury, the payments due being withheld "on every kind of frivolous pretence."

It must be conceded that if this allegation be true it constitutes a very grave sort of scandal. We quite understand the kind of retort which would be made if the question were pressed. A demand would be made to our contemporary for its "authority." That authority would not be forthcoming, so the whole matter would be dismissed by the Government apologist with a shrug. Yet it should be easy to understand that a grievance may remain unredressed, through the reluctance of those who have legitimate complaints, to injure their future prospects by representations which would certainly be resented. Our conviction is that the *Daily Mail* is fully justified in its allegations, and that the probabilities are we shall witness during the current year a rapid progress in making up the arrears which have now risen to such a total.

That is, of course, to presume that the vagaries of the Treasury Department will be rectified in future; but the *Saturday Review* is good enough to offer another solution of the difficulty: "There may," it concedes, "be something in the conditions of the Admiralty orders which press hardly on private firms—too rapid inspection of material, or unfavourable terms of payment not attached to other work; the fact remains that if a foreign government comes to this country for a

battleship or a cruiser it is delivered within a reasonable time."

To the common-sense individual it would seem a wise, as well as an equitable policy for the British Government to accord terms of payment to private constructors at least as advantageous as those they obtain from foreign rivals. But this aspect of the case does not appear to strike our contemporary, who suggests instead the taking away of the Government business private shipyards have been receiving, and its transference to new Government docks. "Do not," it exclaims. "All the facts point to the necessity of adding to the resources of the State for building and equipping war ships? . . . We need more places entirely devoted to Government work. These a far-seeing Minister would take early steps to provide."

We venture to predict, in spite of the authority of the *Saturday Review* on subjects of engineering practice, that it will be a bad time for this country should its counsel be accepted and private engineering enterprise in the service of the State discouraged. Private engineering shops and private shipbuilding yards have ever been the pioneers of progress in the equipment of both the army and navy. Almost every invention of note that we now see in state military and naval employment has been evolved and worked out by private inventors and private engineers, and urged on the acceptance of the authorities under every circumstance of discouragement. The War Office, indeed, whilst acclaiming any fancied "Service" improvement, is the natural enemy of the private inventor. What a patient persevering persistence is required to induce the War Office to even "look at" an improvement that may threaten in any way to disturb existing conditions? When invention is flouted, improvement discouraged, and every obstacle set in the way of attempted reform, what wonder is it that British manufacturers put their plans patiently in their pockets, and resignedly submit themselves to turn out War Office material to War Office specifications, conscious though they may be of possessing improvements which under ordinary commercial circumstances would displace the originals at a moment's notice? Not their pockets, but their patriotism suffers; but they must accept the inevitable.

In face of this, we are assured we want more Government dockyards, and more Government arsenals!

Standardisation of Electrical Plant.

THE extraordinary want of uniformity which prevails in the equipment of British Electricity Works has long been a subject of comment amongst engineers, and, having regard to the increasing demand for electrical plant, it is to be hoped that the valuable paper dealing with this subject recently presented to the Institution of Electrical Engineers by Mr. R. Percy Sellon, will be the means of securing a measure of uniformity superior to that which has hitherto existed.

The author points out that although standardisation is not possible during the early stages of a new industry, the time is now ripe for the standardisation of electrical plant to the common benefit of both producer and purchaser.

The adoption of this principle would enable the former to compete with a greater chance of success against his foreign rivals, while the latter would reap the advantages of reduced capital outlay, quick delivery, freedom from risks attendant on novel designs, and full manufacturers' guarantees.

Attention is drawn to the increasing importation of American electrical plant in spite of the advantages our manufacturers enjoy in respect of lower wages, materials which on the whole are less costly, and a more extended experience of factory organisation. There is no doubt that the success of our cousins can be attributed in some degree to the

fact that, owing to their methods of standardisation, they can supply from stock, machines which in this country would not only have to be made to order, but also to be designed.

The relative lack of uniformity which exists is due in the opinion of the author to the following difference of procedure.

In America and on the Continent, the most important orders are obtained from large financial combinations and industrial banks. The manufacturers are given a free hand, and have consequently designed standard sizes. In this country, the bulk of the work is supplied to local authorities, who are represented by consulting engineers.

These experts have, in many cases, not only specified their requirements, but have also fettered the producers by detailing the manner in which these requirements are to be secured, *hinc illæ lachrymæ*.

The following practical recommendations are submitted by Mr. Sellon, with the object of improving the present state of affairs:—

(1.) Consulting engineers and purchasers should confine themselves to stating the ends or performances which they wish to obtain, leaving the producer to work out the means or constructional details. These ends should be standardised and might include steam pressure, electrical pressure of generation and distribution, periodicity of alternating plant, sizes of steam dynamos, sizes of mains, motors, transformers and lamps.

(2.) The whole question should be considered by a representative committee of the Institute of Electrical Engineers, with the object of formulating a set of standards, acceptable to both producers and purchasers.

At the discussion of the paper there appeared to be a general feeling in favour of the author's proposals, and we trust that the matter may be carried to a successful conclusion.

The two most important standards to be settled on, are pressure of distribution and periodicity. It is therefore to be regretted that this question has not received attention before. All our large towns, and many of the smaller districts have now established works for the supply of electrical energy, and some half-dozen pressures of distribution are in use, while no less than thirteen different periodicities have been adopted, the total number of works in operation being one hundred and sixty.

In many instances a change in pressure or periodicity is now out of the question, as it involves an almost impossible expenditure. There is, however, an immense amount of work to be done before electricity can be universally known as the "poor man's light," or the electric tram as his carriage, and it is not unlikely that we may yet rejoice in a standard lamp pressure of 250 volts.

The electricity works of the near future will bear but little resemblance to many of those which now adorn the country, and much may be done when they are being planned.

Although it is true that consulting engineers have not infrequently hampered contractors by insisting on their own particular fads and fancies, it is unlikely that they would refuse to embody in their specifications recommendations made by leading manufacturers with a view to securing some measure of uniformity.

The most capable experts are generally willing to accept, at all events to consider, the suggestions of the producer, whose practical experience they recognise is likely to be superior to their own; this is, however, not invariably the case in the electrical industry. There is little doubt that if manufacturers had devoted more time in the past few years to working out methods of standardisation, and less of their energy to damning the designs of their rivals with faint praise, much progress would have resulted.

It is not so long since the only means of salvation—so far as electric lighting was concerned—was affirmed to lie in the use of rope-driven machines having a periodicity of 100 alternations. Where are those dynamos now? Rope-driving is obsolete, and a periodicity of 50 alternations is practically agreed on for all ordinary work. The consultants have acquiesced without a murmur!

American standard plant for electric

traction has also been accepted in the same manner, while standardised quick revolution engines are specified with singular brevity.

Experts do, however, lay themselves open to criticism for demanding such absurd sizes of steam generating sets as 56, 84, or 165 kilo-watts, and other equally ridiculous requirements. The labour involved in fixing upon these outputs must be immense. Want of enterprise on the part of the producer is the chief obstacle in the way of uniformity. It is also responsible for obsolete methods of production and antiquated systems of factory organisation.

The situation undoubtedly lies in the hands of the manufacturers of electrical plant, who would, we feel sure, receive every assistance in the matter from the majority of consulting engineers.

To blame the latter for their own supineness is neither reasonable nor just.

Applications of Heated Air.

CONSIDERABLE use is already being made in this country of heated air in connection with various industrial undertakings, but we think it might with advantage be still further employed by British manufacturers.

Drying and seasoning processes, whatever be their exact object, are invariably governed by clearly defined natural laws. In nature, evaporation is restrained by the weight of the superincumbent atmosphere, which keeps other substances within their proper spheres. Nevertheless, vaporisation takes place to some extent under all circumstances and at all temperatures, bearing a definite relation to the elastic forces of vapours evolved from various liquids. It is also affected by the pressure, velocity and humidity of air passing over liquids, and by the surface exposed to its influence. These conditions must always form the subject of inquiry when dealing with appliances for evaporative processes. By the aid of calculation the required volume and temperature of air may readily be determined, as also the number of heat units expended. Economy is frequently attained by the utilisation of waste heat from various sources. The most satisfactory test of any apparatus as to efficiency is to be found by an examination of respective temperatures and degrees of humidity of air at the point of exit. It is always desirable that the apparatus should be designed so as to expose the greatest possible surface and to prevent the escape of unsaturated, heated air. Dry, warmed air should be delivered at various points between the first place of entry and the exit, so that the process may be equable throughout. When employing natural draught it is necessary that attention should be paid to the height and area of the ventilating shaft. The latter condition is very important, because the volume of air to be removed is considerably increased by the presence of vapour. As a general rule, mechanical draught is to be recommended, as it facilitates regulation of the quantity and velocity of air admitted, without risk of disturbance by causes which generally affect systems of natural ventilation. Efficiency is usually promoted by the application of heated air on the positive system, and therefore pressure fans are extremely suitable. Ordinary propellers are not entirely satisfactory when used for blowing, as they are not able to deliver air against pressure. Steam constitutes the most satisfactory medium for heating air, and exhaust steam should always be employed when available. For the treatment of textile fabrics, drying machines are made in great variety, but drying chambers are also largely used. When mechanical draught is used in conjunction with suitable heating apparatus, hot air may readily be distributed from one centre to several separate drying rooms by means of properly arranged ducts. Timber drying sheds have been adopted of recent years in this country, in which the material is stacked on cars, each containing 3,000 to 4,000 ft. of timber; these cars are moved progressively forward on rails, so that their direction is always opposed to the movement of the warm air; thus the timber is exposed to air gradually increasing in dryness as the further end of the shed is reached. Arti-

ficial methods of timber seasoning. conducted on such bases as this, are almost universally employed in the United States, where some of the largest sheds are capable of holding 500,000 ft. of timber, and possess a capacity of drying 125,000 ft. per twenty-four hours. Sometimes seasoning sheds are built in separate divisions, and for the treatment of small pieces and of wooden ware special arrangements of an ingenious nature are contrived. The mode of procedure must be varied in accordance with different classes of timber. For instance, yellow pine should be subjected to a rapid current of air at comparatively high temperature; oak and walnut, on the other hand, require large volumes of air, with considerably less heat.

Arrangements of most complete kind are made, so that the temperature, volume and humidity of air may be efficiently controlled. The drying of bricks is effected in somewhat similar apparatus. Each chamber usually contains about ten cars, with a capacity of 500 bricks.

Drying chambers intended for the preparation of wall-paper, glass-paper, &c. consist of rooms fitted with travelling rods, and heated air is blown along the floor.

Chemicals, salt, sugar, starch, paint, and grain are usually desiccated on perforated shelves or screens, and air passing through the drying rooms should move at a low rate of speed, because the nature of such substances permits the exposure of relatively small surfaces. In the drying of fibrous materials, such as wool, hemp, silk, &c., frames are used, having the top part formed of wire-work; air is then blown from beneath through the material, which must be loosened and turned occasionally to ensure uniformity. A progressive system of drying by warmed air is now being successfully applied to the treatment of tobacco, for which it was once supposed natural evaporation only was suitable.

In most of the evaporative processes to which we have called attention, success is largely dependent upon the provision of mechanical draught by the aid of air propellers and blowers. At the present time there are numerous forms of such apparatus before the public, most of which may safely be said to be thoroughly efficient; and choice, therefore, depends somewhat upon personal preference, though in many cases it may be influenced by the nature of the work to be performed. Although fans have been used for many years past in the ventilation of mines and of public buildings, it is only within comparatively recent years that they have been generally adapted to the requirements of manufacturers. Many industries owe a considerable debt of gratitude to the enterprise of engineering firms, who have introduced efficient fans of small dimensions at reasonable cost.

Electric Traction.

MUCH has been written about and very great developments have taken place in electric tramway construction, and it has been generally assumed that Great Britain's efforts in this direction have been much behind other countries, and notably America. Whilst this statement is partly true when measured from the standpoint of the application of the system, it must always be borne in mind that many of the main problems connected with the principles of modern electric traction were solved by our leading engineers as far back as 1883 and earlier, but that until quite recently legal restrictions and other difficulties retarded all enterprise in the carrying out of their ideas.

This retardation has not been all loss, as it has enabled us to select the best and most approved systems, and to work on the experience gained by other countries before applying them here. Whilst it can hardly be expected that we shall for some little time attain to the mileage laid down in America, which has reached the enormous total of some 15,000 miles of track upon which are operated 40,000 to 50,000 cars, yet there is every indication that the next few years will see considerable extension of the electric tramway system in this country. Moreover, judging from what has taken place in those countries which have both appreciated and been in a position to adopt electric energy for this purpose, it may be assumed that not only shall we very greatly increase our

present tramway mileage, but horse traction will shortly become a thing of the past. In America we find that in the last 10 years horse traction has decreased from about 5,500 miles of track to under 700 miles, whilst electric traction has in the same time grown from under 100 miles to about 15,000 miles; and bearing in mind that with the exception of about 400 to 500 miles of steam or cable-driven lines, that electric forms the chief system, it will be seen that electric traction is the power adopted to drive cars over 90 per cent. of the total tramway mileage. When we consider the question of cars we find the same result: the horse cars have decreased from 20,000 to 3,000, whilst the electric cars have increased from 200 to 40,000.

Coming to this country, we had in 1897 about 200 cars operated over about 300 miles of track, but since then a considerable extension has been made, and there are at the present time a number of important undertakings in progress. It may be interesting to notice that the following towns and districts have already adopted the system, viz.:—Bristol, Halifax, Bradford, Leeds, Sheffield, Dublin, Middlesbrough, Coventry, Isle of Man, Guernsey, Norwich, Kidderminster, Blackpool, Cork, Hartlepool, Dover, Glasgow, Liverpool, Blackburn, &c. Then, of course, we have the City and South London and the City and Waterloo in London, whilst amongst those contemplated or under construction at the present time are:—Hull, Plymouth, Central London Railway, the North Staffordshire Electric Tramways, the Dudley and Stourbridge line, and the Oldham and Hyde route, besides several others. Even with the improved legislation which we now enjoy, there still exist great restrictions both in regard to speed, way-leaves, and in many other directions, and consequently any rapid application of electric traction in the form of a boom can hardly be looked for in Great Britain. Nevertheless, there is a fine field open for our electrical engineers, and it is to be greatly desired that our car and carriage builders will see their way to secure the bulk of the orders. Patriotism and attempts at profit-earning do not always run together, and the only way to control the business is to put upon the market cars and locomotives as good in quality and as favourable in price as our foreign competitors. We believe, and we think we are justified in so assuming, that it is not the inability of our manufacturers to cope with the demands made upon them from an engineering point of view, but rather that the present unprecedented boom in all engineering concerns has illustrated the fact, that if this country is to maintain its leading position, it must greatly increase its facilities for output, and this is particularly the case in the building of electric locomotives and tram cars.

Whilst we naturally look to our leading engineers to assist in the development of this far-reaching and important enterprise, there is no doubt that their energies will not bear the fruit desired, until such time as the general public are convinced of the great benefits to be derived from the adoption of electric traction. Bearing in mind the greatly increased powers now given to local authorities, and thereby placing the matter to a very considerable extent within the hands of the individual through their votes, it is at once seen that their co-operation is essential to success, notwithstanding all that may be done by private enterprise.

Warfare under Water.

SHOULD the grandiose programme recently announced for the reconstruction of the French navy be carried into effect, there will be at the end of 1905 some 30 to 40 submergible torpedo-vessels at the command of our neighbours across the Channel. The experiments of the last eight years appear to have resulted in assuring French naval engineers of the utility of this species of weapon, so that it is natural the almost contemptuous indifference which our own experts have displayed towards it should arouse some uncomfortable speculation in the minds of ill-informed people.

The British public may rest quite easy. The loudly advertised exploits of the French submarines have been noted by

our naval engineers with the utmost tranquility. A short review of the salient features of the subject will show their composure to be amply justified.

As an attacking, or even a defending force, the submarine presents almost every drawback. When in action, a submarine might almost be compared to a blinded man wandering about with a quantity of dynamite, which he is quite as likely to bestow upon his friends as his enemies. It is admitted by even its wildest advocates to be useless but for harbour defence, and in that respect the implement is deemed, and rightly so, by English naval experts to have a value which is safely negligible. The primary difficulty which assails the submarine—that of finding its way below the water—is compli cated by the necessity of balancing and vertical steering. The minutest variation in this respect from a correct course must result in one of two things:—the boat will either stick its nose in the ground, or make a sudden emergence into the open air, which latter feat in presence of a blockading squadron would probably be little less disastrous.

How far the romantic genius of Jules Verne may be accountable for the evolution of a weapon which, in face of the overwhelming British naval superiority, appeals with peculiar force to French national sentiment, it would be hardly profitable to discuss. But the basic idea of the submarine vessel is essentially that of Jules Verne's fantastic creation, though lamentably behind its imaginary progenitor. To career here and there below the waves with stealthy swiftness, invulnerable and invisible, dealing its deathly blows unseen at the vast floating fortresses of a British fleet—that is the popular conception in France of the submarine torpedo-vessel now occupying French artificers. The conception is one hardly warranted by the present circumstances of this creation. In the first place, the highest below-surface speed of the submarine, actuated as it must be by secondary batteries, does not exceed eight knots an hour; in the second, to discharge its torpedo with even a remote chance of effect, it must first locate its antagonist, and it can only do this by rising to the surface to obtain its bearings. In the execution of this manœuvre it would assume all the defencelessness of an ordinary torpedo boat without possessing its mobility, for even a limited surface exposure would present a deadly target to the enemy's quick-firing guns. Even under the most favourable circumstances, such as those of fog or darkness, the accuracy of the submarine's torpedo aim would depend almost altogether on the assumption of the enemy's remaining still to be shot at, since even a small movement after the sighting had been made would be sufficient to cast all the attacker's plans into confusion.

Under these circumstances, it may not be out of place to recall a fact that appears to have momentarily faded from the public recollection. It is this:—the British Government at the present time are in possession of incomparably the most formidable engine for harbour attack and defence that exists in the world. The Brennan torpedo, that marvellous mechanical creation, possesses all the advantages of the war submarine without one of its defects. In its essential features there is no comparison at all. The secrets of the talented Australian are jealously guarded by the Admiralty, and the mechanism of the Brennan torpedo has never been inspected by even any of the foreign attachés who a short time since were accustomed to freely perambulate our Government dockyards. Everyone connected with its manipulation is bound by oath to secrecy. The Brennan dirigible torpedo is operated from shore, or from a point whence its movements can be directed and controlled. During its evolutions, it never emerges from below the surface, its position being indicated merely by a small flag-staff cutting its way hither and thither through the waves. Its speed is far beyond that of the fastest cruiser, and no hostile ship coming within its range possesses the least chance of escape. It has a range adequate to all eventualities, its operation is swift, sure, and deadly. With the consciousness of possessing a monopoly of this instrument, which is probably one of the most formidable war appliances ever evolved, the

imperturbability of our naval authorities towards the vaunted submarines can be satisfactorily accounted for.

The Exportation of Steam Coal.

WHILST the scarcity of steam coal has been a subject of general complaint from one end of this country to the other, it is certainly curious that its export should have increased in volume just at that period when it might be supposed most difficult to procure. Although no very material change is noticeable in its export to the majority of the chief ports abroad, it is notable, and perhaps significant, that France has lately, as nearly as possible, been doubling her imports of coal from this country. The increased volume of the export is mainly attributable to this fact, though this has not been touched upon in the many references which have been made to the subject in the general press.

We believe that the time may come, should the exports of coal continue to augment in anything like the ratio of recent years, when the resources of our coal seams will give rise to a greater apprehension than exists at the present time in the minds of many thinking men.

As was recently pointed out by Mr. Ellis Lever in the columns of a daily contemporary, the quantity of coal we are raising in the United Kingdom is about 220,000,000 tons a year, or twenty-two times the quantity raised at the beginning of the nineteenth century. Without being unduly pessimistic, is it not possible that at this rate our national coal stores may be very rapidly exhausted? It is worthy of note that every Power in Europe is securing our coal, for various purposes, to the extent of from thirty to forty million tons a year. The question to be decided, and, we think, possibly in the near future, is: Can we afford to allow this national British product, which has been the backbone and is practically still the mainstay of all the great industries of this country, to be exported in such huge and increasing quantities under present conditions? The apparent lack of national interest in this question seems to us inexplicable. The fact does not appear to be generally recognised, or, if recognised, taken heed of, that larger importations by Continental Powers are being daily arranged for, and that the import duties are being either reduced or entirely abrogated. At the moment of writing, for instance, we understand that a contract for 140,000 tons of smokeless Welsh steam coal has been made for the Russian navy.

In spite of reasons associated with the doctrinal sanctitude of Free Trade, we think that sufficient justification would be found, in the interests of British trade and manufactures, for some adequate steps to be taken to prevent the undue exportation of this invaluable combustible.

The most drastic and, perhaps, the most effective method would consist in either the prohibition by the State of the sale of fuel to foreign countries, or by the imposition of a tax, such as has been suggested by Mr. Ellis Lever, on all coal exported. But it is quite conceivable that the exportation could be checked by a very simple expedient—the purchase by the Government of all open stocks of steam coal on the market. Anthracite coal, we believe, keeps fairly well; at least, it does not deteriorate nearly so fast as coal of the bituminous kind, and there is probably sufficient accommodation on many of our coaling stations abroad for much larger stocks than they carry at present. Certainly the discussion of such precautions cannot be premature when it is considered that the present time has been chosen, when coals have attained a price unprecedented for many years, by the chief naval power next to our own to double its purchases of coal from this country. The urgency for these extra supplies must have been great; what the nature of that urgency may be, it is not necessary for us to speculate upon, though we should hardly imagine it to be one of a purely industrial character.

Apart from this matter, the question is, of course, how far the increase in the price of coal is to be considered permanent. The prospect is certainly serious, for there appears no valid reason for anticipating any material reduction in the near future.

"We are, in the vastness of our possessions, losing our grip on national sentiment. It is our duty to maintain intact, and to defend by sea and land, all that our empire builders have left us. The day that sees the defence of the British Empire sapped, sees the disintegration of the Nation's trade and the hands of civilization's timepiece put back 200 years."—Rt. Hon. Lord Charles Beresford, C.B.

Feilden's Magazine and "Class" Journalism . . .

The influence of Feilden's Magazine is becoming evident in a manner not at first contemplated by its conductors, but none the less welcome. If this Magazine is contributive to the raising of the standard of contemporary technical and industrial literature, we shall regard this as not one of the least important features of the mission we have hitherto been able to carry out so successfully.

The existing body of what are currently termed "class" organs is certainly susceptible of considerable improvement. The majority of these, we are afraid, are considered by their conductors and their supporters alike as mere vehicles for advertisements, and a very small sense of conscientious duty is mingled with their preparation and publication. In looking through the vast masses of contemporary organs devoted to particular subjects that reach our offices, we confess we have been struck by the very modest pretensions, both literary and typographic, with which the majority of them appear to be contented. We do not allege the general characteristic is venal; but certainly the standard is not high. Few appear sufficiently ambitious to endeavour to form or express an independent judgment on the matters they purport to deal with, and many indeed seem to regard their literary columns as the property of, or at least under the control of, their advertisers.

It has been the endeavour of Feilden's Magazine, up to the present time, to apply the methods of high-class journalism to technical literature. At the outset we recognised that those whose support it was our object to secure were of an education and a culture inferior to no class in society; that no effort we could make to produce an organ which, besides providing that practical information it is its chief duty to procure, would appeal to the intellectual instincts would remain unrecognised. Our anticipations have been realised with a liberality we hardly dared to hope for. The recognition has been prompt and widespread, and may well inspire us to further exertions in the path we have chosen.

More About Fog-Signalling . . .

In our February issue some comments were made with regard to recent railway accidents, and we then called attention to the urgent necessity existing for concerted action on the part of railway companies with the view of arranging for the adoption of some scientific system of fog-signalling. Sir Francis Marindin has now reported to the Board of Trade the result of his inquiries into the circumstances attending the collisions at London Bridge and at Wivelsfield. It is satisfactory to observe that he entirely endorses our own opinions as to the wholly unsatisfactory nature of present methods of fog-signalling. Speaking of the London Bridge accident, he says: "As is usual in the case of sudden fogs, the arrangements for fog-signalling on this occasion proved to be inadequate." He comments upon the facts that the signalman took no steps to procure the aid of fog-men; that

neither he nor the inspector knew there were no men available at that time for emergency work; and that, owing to the partial nature of the fog, the inspector in charge at London Bridge, where the atmosphere was clear, could not know that fog-men were wanted at another part of the line where foggy conditions prevailed. In conclusion, Sir Francis emphasises the need for improvements in methods of signalling, and says the railway companies ought to take serious steps to select some appliance which will at any rate enable a signalman to protect the line until the arrival of fog-signalmen at their posts, and he hopes the question will be energetically taken up by the associated companies so that some uniform system may be adopted.

Referring to the Wivelsfield accident, Sir Francis Marindin first remarks upon the disregard of rules evidenced by the engine-driver, and upon the apathy of the Burgess Hill stationmaster, ganger Tullett, and signalman Edwards. He then expresses his conviction as to the necessity for some better system of signalling, and proceeds to say that some one of the numerous devices already invented ought to be found suitable for adoption. Once again he takes an opportunity of recommending concerted action on the part of the associated companies. To the London, Brighton and South Coast Railway in particular he tenders the advice that they should lose no time in adopting the more modern code of rules drawn up by the associated companies, and especially that they should alter their signalling arrangements at Wivelsfield.

This question of fog-signalling is clearly one of vital importance, and might well be taken up by Parliament, if the time of that assembly were not so much wasted in futile party strife, and so over-occupied in one way or another by well-meaning though ill-advised faddists.

Boiler Registration and Inspection Bill . . .

THE first attempt to deal with the question of boiler registration in an adequate manner was made when Sir W. H. Houldsworth introduced a Bill into Parliament during the year 1892. A second effort was made in 1897, by re-introduction of the same Bill, and the third is signalised by the measure of which the second reading was proposed on the 8th of March by Mr. Fenwick.

The objective in each case is worthy of support from every conscientious boiler proprietor, but an important difference is evidenced in respect of the manner in which the object is sought to be attained. Sir W. Houldsworth did not suggest that the work of inspection should be placed in the hands of any Government Department, but that the owner should be left free to select his own inspector, as at present, the Bill making due provision for his being responsible for the suitability of his choice. Thus the Bill as drafted would not interfere with the careful user, and would only affect careless steam users by whom inspection is regarded in the light of an unnecessary luxury. This Bill was the outcome of work done by the Manchester Steam Users' Association, which is not a commercial company, and has no proprietary rights, nor does it pay dividends. It goes without saying that the Bill received the approval of other corporations undertaking similar work, though with a view to the earning of profits. But it would have been open for any really competent engineer to become a boiler inspector under the Act. The latest Bill proposes the appointment of Government inspectors, and considerable opposition is already in evidence against this form of supervision. All Government offices must inevitably be conducted at much greater expense than is incurred in mercantile establishments, and, to put the case mildly, it is not certain that public servants are usually encouraged in the exercise of zeal and industry, whilst it is common knowledge that some existing departments require thorough organisation at the present moment. Under these circumstances, we hold the opinion that the enlargement of departmental work should be discouraged, at any rate until it can be shown conclusively that Government offices can be managed upon the same businesslike basis which prevails in mercantile and industrial circles. For

the present, the Bill has been referred to a Select Committee with the view of producing a comprehensive and workmanlike measure on the subject, and this course is all the more desirable for the reason that the Factory Bill, introduced the other day by the Home Secretary, also involves boiler inspection to some extent, and it would be absurd, as Mr. Bryce pointed out, to have Home Office inspectors visiting a factory for one purpose, and Board of Trade inspectors coming to the same premises for another purpose.

The Trans-Siberian Railway . . .

THERE seems a disposition in some quarters to cavil at the details of construction and the general efficacy of the great railroad across Siberia, perhaps in order to make it appear a less important factor in the future direction of Eastern trade, but to judge from opinions expressed in a lecture by the Austrian Vice-Consul, Mr. Nicolaus Post, who personally inspected the whole line, and whose lucid report of what he saw is published in the recent issue of an Austrian contemporary, the great Russian railway must be considered a remarkable engineering feat, as well as an enterprise that is destined to bring about very important changes in the commercial and agricultural prospects of Russia, and to be of no slight interest to her competitors in the East. There appears to be no doubt that the Trans-Siberian railway shows many signs of hasty construction, and that some portions of it plainly indicate that they are of a merely provisory character; it is equally certain also that as regards speed the working cannot compare with that of any other European railway, for it takes the ordinary passenger train 4½ days, and the express 3½ days, to cover the distance between Moscow and Irkutsk, *i.e.*, 1,850 kilometres; nevertheless, considering the short space of time in which the line was constructed, the enterprise deserves admiration. Within a few years Russia has succeeded in connecting her extensive possessions in Northern and North-Eastern Asia, heretofore merely known as an ice-bound prison for criminals and political offenders, by means of a railway line into the heart of the empire, and to open them to settlement and agricultural development. Like ourselves, and unlike most Continental nations whose surplus population must seek shelter under a foreign flag, the country of the Czar possesses immense, and as yet uncultivated, districts in which there will be room for many generations still, so that the Russian emigrant, if he desires, can found himself a new home without leaving the limits of the empire. Nor must it be imagined that Siberia, as is popularly assumed, is merely a region of eternal snow and ice. It has long since been made known by travellers that great portions of that country, above all those that will be opened up by the new railway line, are splendidly adapted for farming and cattle-raising, and that there are hidden under the soil rich mineral treasures which merely require facilities of transport in order to become a source of great national wealth. That the people of Russia realise the advantage to be derived by settlement in the East is seen from the activity that begins to reign in Siberia. The emigration of farmers from the western portion of the country into the newly-opened districts amounted last year to nearly 100,000. Western Siberia has begun already to send annually-increasing quantities of grain to the markets of European Russia, and portions seem even to have entered Austria, so that the prophecies that Siberia will ultimately become a rival, as regards grain-production, to the United States may perhaps be fulfilled.

The chief importance, however, of the Trans-Siberian railway for foreign countries is that, notwithstanding the fact of slow speed, it will be possible to reach by it Port Arthur, on the Pacific, from Moscow in from 14 to 16 days, which may in the near future be reduced to 11, and from Port Arthur to Peking is but a few days' journey, while the distance to Shanghai, the great commercial centre of the Yangtse-Kiang, is even less, and, considering the rivalry of the great nations in obtaining the commerce of the Chinese Empire, the new railway line, notwithstanding the fact that the maritime transport is sure to become less expensive from

day to day, offers facilities that will bring to it a great percentage of the Eastern trade, and confer great benefit upon the country that owns it. At all events, the Trans-Siberian railway, whatever its defects, gives to Russia considerable advantages in the future which her competitors cannot pass over with indifference, and with which they will have to count in calculating the chances of their own Eastern trade.

Repetitions of Stress on Iron and Steel . . .

SOME further experiments, with the object of ascertaining the effects of repetitions of stress on the elastic properties of iron and steel, have lately been made by Professor Sondericker of the Massachusetts Technicological Institute. His tests were made upon rotating pieces, subjected to high degrees of flexure, in which the stresses were equal to or above the elastic limit, and the loads were so applied that alternations of tensile and compressive stresses were produced. Under such conditions it may be assumed that distortion of individual fibres takes place, to some extent independent of that experienced by surrounding fibres, and the experiments probably represent the conditions existing in railway axles, apart from shocks caused by inequalities of the permanent way.

Professor Sondericker directs attention to the fact that appreciable deformation occurs at points considerably below the elastic limit, and, in many cases, his experiments resulted in fracture. It is sometimes supposed that repetitions of stress below the elastic limit will not cause failure, even though application be indefinitely repeated, but a different conclusion is arrived at by Professor Sondericker, who, in this respect, confirms the earlier experiments of Wöhler. From the published results of the later tests to which we refer it is not perfectly clear upon what basis the elastic limit of the material has been ascertained, and this uncertainty somewhat detracts from the value of the records. It is, however, evident that permanent set will take place during repeated alternations of stress, at a point far below the elastic limit as determined by applications of one kind of stress only. As Professor Sondericker applied stress approximately equal to the elastic limit taken by him, he found nothing to show at what point below the elastic limit metal experiences fatigue when exposed to repetitions of stress. It would be highly interesting to know whether fatigue is suffered in constructional work by iron or steel, which is seldom exposed to stress intensity of more than half the elastic limit. The general consensus of opinion is that fatigue is not caused under the latter condition, but exactly what may be expected when alternations of stress are caused, no one knows. Further investigation directed to the elucidation of this point is clearly desirable.

A Commercial University in Germany . . .

IT seems that Germany is keenly aware of the fact that her remarkable progress of recent years in the development of trade and industries is pre-eminently due to the thorough education rendered accessible to her youths, and she is ever anew devising means to render her educational system more perfect. The latest and very successful experiment has been the establishment of a commercial university at Leipzig, which was founded about two years ago, and in which the first two years' course of instruction required for its students is approaching its end. There have been in Germany heretofore commercial schools of two different ranks, namely, the "commercial continuation schools" (Fortbildungsschulen) intended to give elementary education to young clerks, especially those employed in the retail trade, and the so-called "commercial schools" (Handelsschulen), similar to the commercial colleges in this country, offering a thorough practical education in the requirements of a commercial career, such as knowledge of modern languages, book-keeping, banking, commercial arithmetic, geography, &c. There was, however, no educational establishment for commercial students ranking with the universities and so-called technical high schools. The new school at Leipzig under the title of "Handelshochschule"

is the first experiment of its kind, and is sure to be followed in the near future by others, as it has proved entirely successful. It was at first anticipated that in the beginning hardly more that 50 students would enter their names, but in reality 97 students were matriculated during the first semester of the two years' course, and 139 in the second semester, of which 36 were foreigners; while, during the present, *i.e.*, the fourth semester, at the end of which the successful students of the first semester will graduate, 248 students were matriculated, exclusive of the so-called "hearers" that are attending without possessing full privileges, owing to their not having the preliminary education required from natives of Germany.

The course of instruction at the institution comprises most of the branches of knowledge which will prove useful to those occupying the most prominent position in commercial establishments, or in charge of extensive commercial enterprises. Amongst the subjects taught may be mentioned practical economics, public finance, commercial and maritime law, the history of trade, history of colonisation, theory of modern social institutions, international law, statistics, social problems, commercial geography, modern political history, economic and constitutional history, chemical technology, practical training in modern languages—notably Chinese, French, Italian, English, Spanish and Russian. The language studies are conducted rather with the object of obtaining efficiency in conversation and correspondence than with regard to literary and philological knowledge. Besides such instruction as is given in the Commercial University, the students have the privilege of attending all lectures at the old-established university, and of selecting such subjects as are of special interest to them. After completing the two years' course, the students who desire to graduate can choose between two kinds of examinations—the first intended for those who desire to actively engage in trade, the second for those who wish to become teachers. Both examinations are fairly difficult to pass, but the training is of so excellent a nature that graduates will find it comparatively easy to obtain responsible positions; and there is no doubt that the establishment of institutions of such a kind must prove beneficial to the country in which they exist. Our cousins of the United States, always eager to secure the latest improvements, have sent experts to study the methods of the Leipzig establishment, who speak so enthusiastically of what they saw, that the foundation of American institutions of a similar nature is already under serious contemplation.

Miners' Eight-Hours Bill . . .

PERSISTENT efforts have been made in past years, and no doubt will continue to be made, with the object of limiting the hours of work in mines. Three successive Parliaments have listened to arguments in favour of the Mines (Eight Hours) Bill, and on every occasion, we rejoice to say, the House of Commons has declined to interfere with the freedom of miners to earn money. There is an element of grotesque humour in the idea of the House of Commons presuming to dictate to other people how business should be conducted, especially at a time when overwhelming evidence is forthcoming as to the hopeless incapacity of the House to manage its own affairs with reasonable success and celerity. Of the miners themselves fully one-sixth oppose the measure, and no doubt large numbers object to it who do not make their opinions known. Why miners, of all people in the world, should be picked out for this mischievous kind of dry nursing, we cannot imagine. They earn high wages—so high, in fact, that there is no temptation for excessive hours of labour—they live well, are well clothed, and are popularly supposed to have plenty of time available for more or less desirable amusements. Taking one thing with another, the miner's lot is not particularly an unhappy one, although some part of each week has necessarily to be spared from more congenial occupations, and devoted to work. At the present time, when we are in the midst of a coal famine, the suggestion that hours of labour should be compulsorily

curtailed is singularly inappropriate. Many valid objections exist against legislation of the kind, and some of these may usefully be borne in mind. We have already spoken of unjustifiable interference with the freedom of adult males to work if they wish to do so. Although professing to permit eight hours' work, the Bill really does nothing of the sort, as the net time available would not average more than six hours, when allowance has been made for the time necessarily occupied in going between the pit-bank and the place of work in the mine. Moreover, great injustice would be caused to those men who have to travel three or four miles underground before their appointed places are reached. Competent judges estimate that the effect of the measure would be to reduce the output of coal by 20 or 25 per cent., a result which could only be injurious to the workers, the employers, and the community. To engineering firms this question is of the utmost importance. No one has forgotten the prolonged struggle which ensued in consequence of the demand for a 48-hours working week, and if the principle of an eight-hours day were established by Parliament, it would at once undo all the benefits secured by the Engineering Employers' Federation. Quite enough damage can be done to the true interests of the country by Trades Unionists without legislative aid. In every department of trade we have to face growing competition from countries where longer hours of work than our own are adopted, and where men do more work per hour than the British workman is taught to believe is proper. It will be a disastrous day for our National industries if Imperial Parliament should be persuaded to support the false views of political economy which are so industriously advocated by the apologists of Trades Unionism.

The Great Motor of the Age . . .

THE theorem propounded by Carnot in relation to a purely theoretical engine, reversible in the thermodynamic, and not in the mechanical sense, was to the effect that if an engine working between two given temperatures, receiving a quantity of heat at the higher temperature, and rejecting heat at the minimum temperature, is able to perform a quantity of work, then no other engine can do more work under similar conditions. Thus, the efficiency of a steam engine depends entirely upon the limits of temperature within which it works; increase in one direction depending upon additional pressure, and in the other upon higher condensing power. Even in the case of a theoretically perfect engine, efficiency cannot exceed one-fourth of the total heat supplied, and this is the standard which we may hope to approach, though never to reach. In order to attain this standard, it would be necessary to achieve two things: (1) to take all required heat from the steam between initial and back-pressures after the cut-off point, and (2) to restore it at its own maintained temperature level on completion of the return piston stroke. In the time of Watt, thermal and dynamic losses in steam engines were about 60 per cent. and 20 per cent. respectively; to-day similar losses stand approximately at 20 per cent. and 10 per cent. Therefore it will be seen that the chief advances of the century have been in the direction of reducing thermal, rather than dynamic waste. Looking at the work produced by some types of modern engines, we find evidences of satisfactory progress. For instance, a simple Corliss engine has been found to exhibit a duty of 93,000,000 foot-pounds for each million of heat units supplied in the form of steam; compound engines show as much as 133,000,000 foot-pounds; triple-expansion engines range from 140,000,000 to 150,000,000 foot-pounds; whilst an engine recently tested by Prof. Thurston, which was of the quadruple type, is credited with the duty of 163,000,000 foot-pounds per million heat units furnished. The same engine, compared with the theoretically perfect machine, exhibits an efficiency of 84 per cent., which appears to be very near the limits of possibility. Enough has been said to justify the opinion that the steam engine may still be regarded as the great motor of the age, although we may hope that some day a machine of higher theoretical perfection will be devised.

Notes.

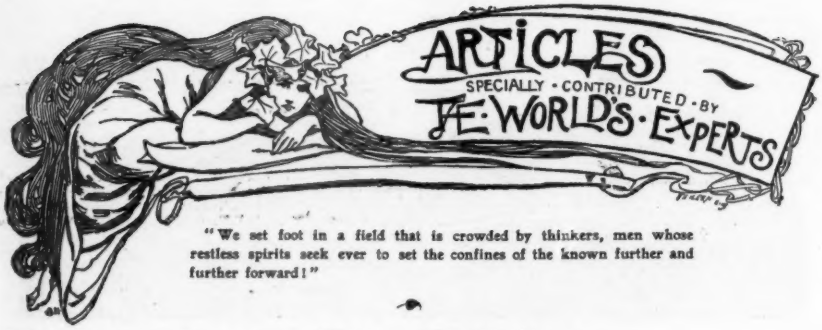
In a recent issue we referred at some length to the agitation proceeding in Canada for the prohibition of the export of lumber from the Dominion. We pointed out the serious consequences such a step would be liable to entail on the paper manufacturing industry of the United States, whose own stores of pulpwoods are practically depleted. We observe that the Ontario Government have now passed an Order in Council prohibiting the exportation of all pulp wood grown on Crown lands in the Province. As the United States are to a large degree dependent on the supply of this raw material for their paper, it would appear, should the example of Ontario be generally followed, that a papermaking industry will grow up in Canada far surpassing its present dimensions, to the prejudice of that of the adjoining country.

A contemporary has discovered (1) that there is a vast eakage going on in existing gas mains, and (2) that the leakage percolating through the soil into the atmosphere is prejudicial to the public health. Were there any truth in this contention we can imagine with what eagerness it would be welcomed by the electric lighting companies, but we are afraid they will have no opportunity of using such an allegation to advance their interests. One is tempted at the first consideration of the proposition to inquire what becomes of the smell. The answer is, that the smell is absorbed during the filtration of the gas through the earth.

The "Brown System," we learn, "has been introduced on the Southern Railway." What is the "Brown System?" It is an American institution, and is set forth in the "Inaugurating Bulletin" as follows:—"A discipline record book shall be kept in the superintendent's office in which an entry shall be made of every case of neglect of duty, violation of rules, bad conduct, etc., with the penalty imposed. There shall also be kept in this book a credit account, in which record shall be made of excellent conduct, deeds of heroism, loyalty, etc., which shall be given full consideration in connection with the charges entered against each employé. These books shall be open to the inspection of any employé for examination of his own record, but no employé shall be permitted to examine the record of another." The "Brown System," therefore, would appear to be a kind of moral and intellectual bank, invested with a regular debit and credit account to the investor, which he can increase or draw upon at his discretion.

It is proposed to generate electric current on the Canadian side of the Niagara Falls, and to convey a portion of it to the American side to be sold for power purposes. The question has been raised whether foreign-made electricity should not be subjected to a duty of 10 per cent. *ad valorem* as an "unenumerated manufactured article," and a flood of controversy has ensued. In Germany, at least, until lately, it was not regarded as possible to steal electricity. But electric current is now recognised as a measurable commodity, and as such, it is difficult to see how it can escape taxation.

The amount of trade British manufacturers are cheerfully allowing to go across the Atlantic is illustrated by a by no means isolated instance, particulars of which reached us a short time ago. "The Niles-Bement-Pond Company (manufacturers of heavy machine tools) have now taken premises in Victoria Street, Westminster, covering a floor space of 3,800 sq. ft., and have in addition a large storage warehouse where they will keep a large stock of machine tools of all descriptions." We may point out that it has been stated repeatedly in connection with animadversions on the deficiencies in light English machine tools, that though America might excel us in the design and manufacture of these, yet in heavy machine tools we were more than able to hold our own. It is somewhat difficult to reconcile this view with the successful business the American company we have mentioned appears to be carrying on in this country.



"We set foot in a field that is crowded by thinkers, men whose restless spirits seek ever to set the confines of the known further and further forward!"

Compound and Four-Cylinder Locomotives in England and France.

By CHARLES ROUS-MARTEN.

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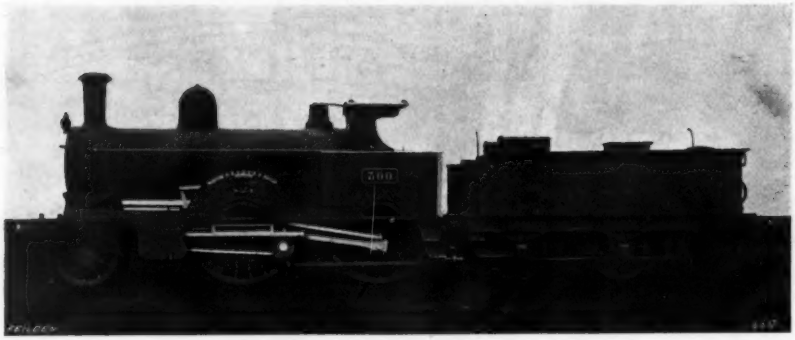
In my article on "Recent Characteristics of British Locomotive Engineering" which appeared in the first number of FEILDEN'S MAGAZINE, I explained that I purposed dealing in a second article with the various classes of compound locomotives which had been introduced in England and France, and also with the two four-cylinder non-compound engines which had been brought out experimentally on the two South-Western lines, the London and South-Western and the Glasgow and South-Western, by Mr. D. Drummond and Mr. James Manson respectively.

At a comparatively early period of British railway history—so far back as the year 1847—the idea occurred to locomotive engineers that an economy of force would be obtained by using the steam twice over instead of allowing it to escape into the atmosphere, after a single expansion, with a large proportion of its work-capacity still unexpended. Various experiments were made in the direction of utilising this remaining energy, but no practical results were attained until M. Mallet, 23 years ago, put the idea into workable shape. His two-cylinder compounds have met with considerable favour on the Continent, but in view of recent developments it will be convenient to deal with them mainly as having initiated the movement which has since been so largely developed by Mr. F. W. Webb and Mr. T. W. Worsdell in England, by M. de Glehn and Herr von Borries on the European Continent, and by Mr. Vauclain and other engineers in America.

Mr. Webb, indeed, states frankly that his first experiment in locomotive-compounding—20 years ago—was made on M. Mallet's principle, an old engine being converted into a compound on this system. The results were so favourable that Mr. Webb decided to adopt the compound plan, but set himself to devise means by which its efficiency might be improved. The outcome was seen in the appearance of his first, or "Experiment" class. The original idea was that these should be virtually equivalent to the standard or "Precedent" class of ordinary non-compound express engine which had proved very successful, and so "Experiment" was given four 6-ft. 6-in. driving wheels, not coupled, however, the rear pair driven by two 11½-in. high-pressure cylinders placed outside the frames and the front pair by a single low-pressure cylinder, 26 in. in diameter, placed between the frames, the latter cylinder receiving the steam ex-



LONDON AND NORTH-WESTERN COMPOUND ORIGINAL OR "EXPERIMENTAL" TYPE. F. W. WEBB'S SYSTEM. CYLINDERS: HIGH-PRESSURE (2) 13 IN.; LOW-PRESSURE (1) 26 IN.; DIAMETER OF DRIVING-WHEELS (4) 6 FT. 6 IN.

hausted from the high-pressure pair. Later the high-pressure cylinders were enlarged to 13 in. and the size was adhered to in the 30 engines of the class.

That they did, and still do, some good work, may at once be admitted, but experience proved that compounding could not be profitably employed for express engines with so low a steam pressure as 160 lbs., and their advent happened—unluckily for their reputation—to prove coincident with a sudden augmentation of speed and of train loads. So no more were built of similar dimensions, but in the next batch, which began to appear in 1884, Mr. Webb adopted 175 lbs. steam pressure, 14-in. high-pressure cylinders, a 30-in. low-pressure cylinder, and driving wheels 6 ft. in diameter. Of this "Dreadnought" class forty engines were constructed and—subject to a qualification to be mentioned later—I have generally found them do good, often excellent, and sometimes almost phenomenal, work. One of this class, named "Marchioness of Stafford," was shown in the Inventions Exhibition of 1885 and was awarded a gold medal.

After the "Race to Edinburgh" in 1888, Mr. Webb brought out another edition of these engines which differed from the "Dreadnoughts" only in having 7-ft. driving wheels instead of 6-ft. Ten were built, and all, with a single exception, were named after popular steamers of the White Star Line, the first being "Teutonic." The exception was "Jeanie Deans," which was shown in the Edinburgh Exhibition, and which for years has run the West Coast Anglo-Scottish afternoon dining-car express each way between Euston and Crewe with remarkable efficiency and success. Other noted engines of this class are "Adriatic," which made the final record run from Euston to Crewe on the last night of the race to Aberdeen in 1895, viz., 2 hrs. 28 mins. for the 158 miles, or at the rate of 64·2 miles an hour, and "Ionic," which performed the unprecedented run of 299 miles from Euston to Carlisle without stop, with an experimental train. The type has been a distinctly useful one.

It was next enlarged, in 1891, into that known as the "Greater Britain" type, which had the same dimensions of wheels and of low-pressure cylinder, but had an extra inch of diameter in the high-pressure cylinders, and a boiler of remarkable length, viz., 18 ft. 6 in., with intermediate combustion chamber. My experiences with these engines have, as a rule, been highly favourable. Ten were constructed, also ten others, identical in all respects save as to diameter of driving-wheels, which was reduced to 6 ft., in order to give enhanced tractive force on the heavy grades between Crewe and Carlisle. With these latter, of the "John Hick" class, I have as yet had no experiences whatever.

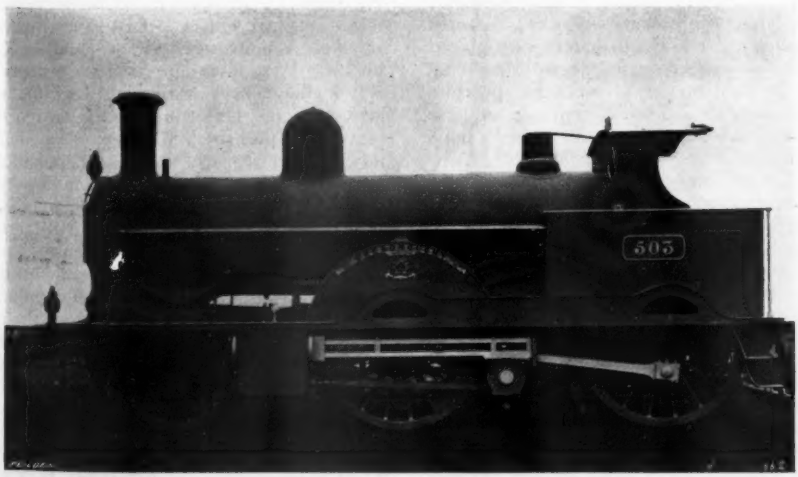
Mr. Webb built several types of tank-

engines on his three-cylinder principle, one of which I illustrate, but these have not been multiplied. On the other hand, his eight-wheel-coupled coal-engines on the same system are being turned out in large numbers from the Crewe workshops, and have proved themselves most valuable for working heavy mineral traffic.

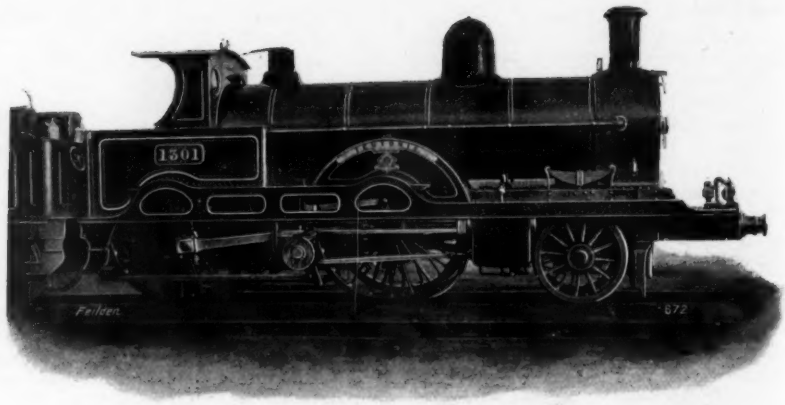
Apparently the three-cylinder method will henceforward be confined to these coal-haulers, for Mr. Webb has now adopted definitely the four-cylinder plan of compounding for his express locomotives, and has already built twenty of this type. He appears to have taken his "Teutonic" type of engine as his basis of departure, employing virtually the same wheels—viz., four of 7 ft. diameter—and the same boiler, with 1,400 square ft. of heating surface, but a higher steam pressure, viz., 200 lbs. But he used two low-pressure inside cylinders instead of one, increased the diameter of the high-pressure outside cylinders by an inch—viz., to 15 in.—and set all four cylinders to drive the front pair of driving-wheels, coupling these to the 7-ft. trailing-wheels, and he placed the leading end of the engine on what he described as "a double radial truck"—a sort of pivotless bogie. Of the two engines in this class first built, one was compound and one simple. The latter had 15-in. inside cylinders, so that the boiler had to fill four 15-in. cylinders with "live" steam, a very heavy demand on its capacity. The other engine, "Black Prince," had 19½-in. inside cylinders which merely received the steam already used by the high-pressure cylinders, so that the boiler was only called on to fill that single pair.

In a comparison between two engines so differentiated, it was a foregone conclusion that the compound would come out the better, and this proved to be the case. The other engine was accordingly converted into a compound, and 18 more were built, the diameter, however, of the low-pressure cylinders being increased to 20½ in. These engines have now become the standard express type on the London and North-Western. In my own experience of their working they have invariably done well.

In 1884, Mr. T. W. Worsdell, then Locomotive Superintendent of the Great Eastern Railway, built a two-cylinder compound express locomotive on a principle whose initiation is shared by Herr von



LONDON AND NORTH-WESTERN "DREADNOUGHT COMPOUND EXPRESS ENGINE. F. W. WEBB'S SYSTEM. CYLINDERS: HIGH-PRESSURE (2), 14 IN.; LOW-PRESSURE (1), 30 IN.; DIAMETER OF DRIVING-WHEELS (4) 6 FT.



LONDON AND NORTH-WESTERN THREE-CYLINDER COMPOUND EXPRESS ENGINE "TEUTONIC." F. W. WEBB. CYLINDERS HIGH-PRESSURE (2), 14×24; LOW-PRESSURE (1), 30×24; DRIVING-WHEELS, 7 FT.

Borries. The engine, No. 230, was identical with the standard 7 ft. coupled class built by Mr. Worsdell for the Great Eastern, except in respect of the compound action and of the leading bogie with which the single pair of radial axles given to the non-compound engines had to be replaced in order to allow room for the large low-pressure cylinder 26 in. in diameter. The two cylinders were placed side by side, the high-pressure one being 18 in. in diameter. The steam pressure was only 160 lbs.—a seriously adverse condition—but nevertheless the engine did some very good work, and Mr. Worsdell built ten more of the same class, Nos. 700-709. Immediately afterward he migrated to the locomotive chieftaincy of the North-Eastern Railway, and his successor, Mr. James Holden, converted all the 11 compounds into locomotives of the ordinary non-compound type.

On the North-Eastern, Mr. Worsdell at once introduced his method, and many engines, both express and goods, were built to his Great Eastern design and proportions, so far as cylinders were concerned, but with larger boilers, and, in the case of the express engines, smaller driving-wheels, viz., 6 ft. 8 in. instead of 7 ft. Subsequently ten 7-ft. single-wheelers were constructed on the same principle, and still with 18-in. and 26-in. cylinders respectively. All have done in their time much creditable work.

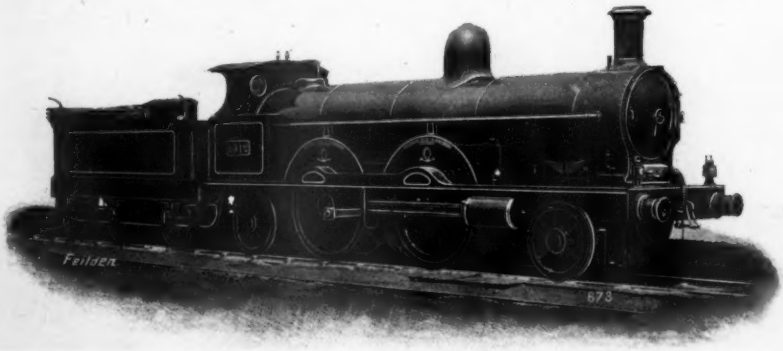
But then Mr. Worsdell took a new and important departure. He designed a larger single-wheeler, with cylinders having the colossal dimensions of 20 in. by 24 in. and 28 in. by 24 in. respectively, also with 175 lbs. steam pressure and 7 ft. 7 in. driving-wheels. With these fine engines remarkably high speeds were run and very heavy loads hauled. Unfortunately the vast size of the low-pressure cylinders compelled the valve-chests to be placed outside, to their serious disadvantage in frosty weather, a tendency to crack being displayed, and so in the end all the large single-wheelers were converted into the non-compound type, with valve-chests inside. There was also a large coupled engine, No. 1619, which Mr. Wilson Worsdell, who succeeded his brother as chief at Gateshead, had built on the Worsdell-von Borries system, the engine differing in this respect alone from 20 new express engines with 7-ft. wheels four-coupled, cylinders 19 in. by 26 in. and 175 lbs. steam pressure, which Mr. Wilson Worsdell constructed at the same time. In this case also the outside chests proved

inconvenient, and the locomotive was rebuilt, but not as a "simple." A new design of three-cylinder compound was adopted, Mr. Webb's method being exactly reversed by Mr. Wilson Worsdell, who employed one inside high-pressure cylinder, 19 in. by 26 in., and two outside low-pressure cylinders, each 20 in. by 24 in., also adding a larger boiler, with water-tubes in the fire-box and 200 lbs. steam pressure. I have seen No. 1619, as thus converted, do some good work but I understand that the type is unlikely to be multiplied.

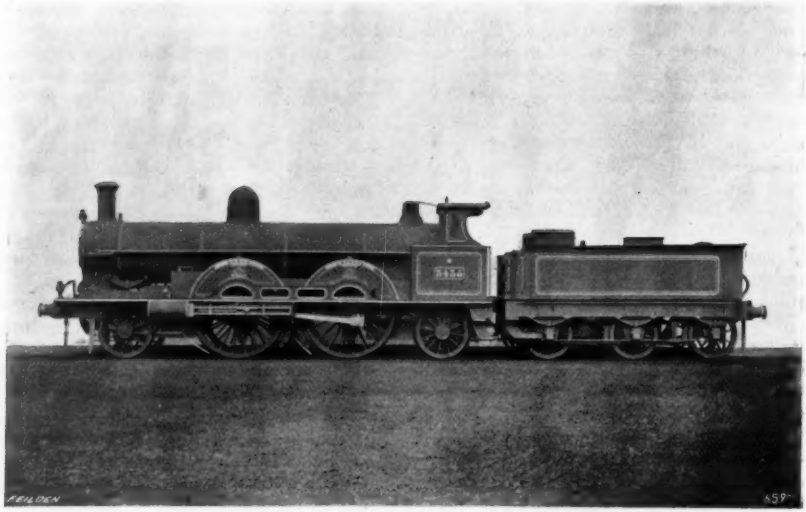
Two temporary, and apparently unsuccessful, experiments in locomotive compounding have also to be noticed. In each case the four-cylinder tandem method was tried. Two engines, Nos. 7 and 8, were built at Swindon for the Great Western Railway, each having 7-ft. coupled-wheels, but one (No. 7) being for the standard gauge, and the other (No. 8) for the old 7-ft. gauge, since abolished. No. 7 was a four-cylinder compound with double frame and outside cranks; the two low-pressure cylinders, each 23 in. in diameter, were placed in front of the two 15-in. high-pressure cylinders. The piston-stroke was 23 in.; heating surface, 1258 sq. ft.; and total weight loaded, 44 tons. No. 8 had 14-in. high-pressure cylinders and 22-in. low-pressure, placed as in the case of No. 7, but the low-pressure pistons, instead of having each one central piston-rod, had two, one near the circumference of each piston, and fixed so as to clear the high-pressure cylinders and to work on one cross-head, with which the low-pressure piston-rod was also connected. There were thus three piston-rods on each cross-head, and the engine had six piston-rods in all. They did not prove satisfactory, and only their wheels still remain, being placed under the new engines "Armstrong" and "Gooch."

A similar experiment was made on the North British Railway, the engine upon which it was tried being the one (No. 224) which had fallen into the Tay estuary when the first Tay bridge collapsed in 1875, and which had lain for some months at the bottom of the sea, yet had been ultimately rescued almost uninjured. This engine ran for a time as a tandem compound, but the results, I believe, were unfavourable. At all events, the plan was not continued, and has not been again tried.

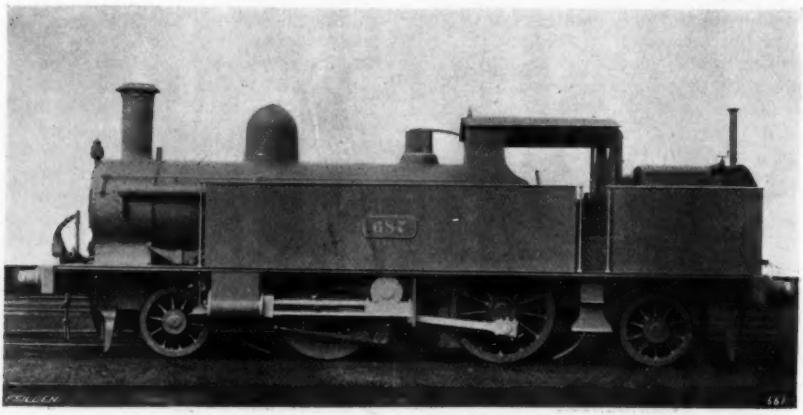
Such is the general history of locomotive-compounding in Great Britain. Summing up the practical results, it may be said that compounding has been absolutely abandoned on the Great Eastern Railway, that it has been virtually abandoned on the North-Eastern, and that the principle only remains in active operation on the London and North-Western, where



LONDON AND NORTH-WESTERN THREE-CYLINDER COMPOUND EXPRESS ENGINE "HENRY CORT." F. W. WEBB. CYLINDERS HIGH-PRESSURE (2), 15×24; LOW-PRESSURE (1), 30×24; DRIVING-WHEELS, 6 FT.

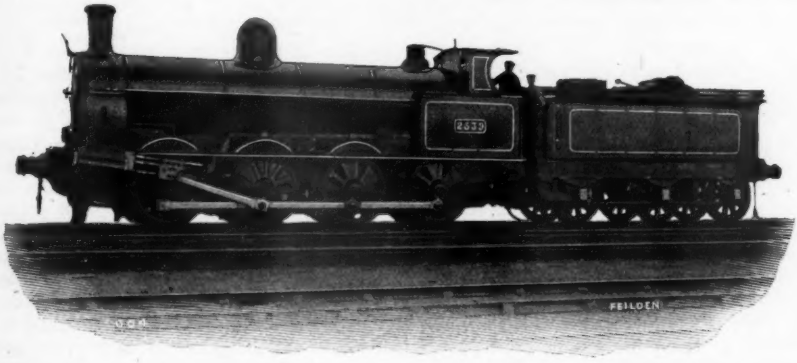


LONDON AND NORTH-WESTERN THREE-CYLINDER COMPOUND EXPRESS ENGINE "QUEEN-EMPRESS." F. W. WEBB. CYLINDERS: HIGH-PRESSURE (2), 15×24; LOW-PRESSURE (1), 30×24; DRIVING-WHEELS, 7 FT.



LONDON AND NORTH-WESTERN, NO. 687, COMPOUND TANK ENGINE. F. W. WEBB'S SYSTEM. CYLINDERS: HIGH-PRESSURE (2), 14 IN.; LOW-PRESSURE, 26 IN.; STROKE, 24 IN.; DIAMETER OF DRIVING-WHEELS (4), 4 FT. 6 IN.

the three-cylinder method is now confined to mineral engines, the four-cylinder system having superseded it in the case of passenger engines; or, to put the case another way, the Great Eastern not only has ceased to build compounds, but also has converted all those that had been built; the North-Eastern has ceased to build compounds, and has converted two classes of those previously built, but still works the rest, including many goods engines; the London and North-Western builds compound engines exclusively for express and mineral traffic, four-cylinder for the former, three-cylinder for the latter, and continues all the three-cylinder express engines formerly built.

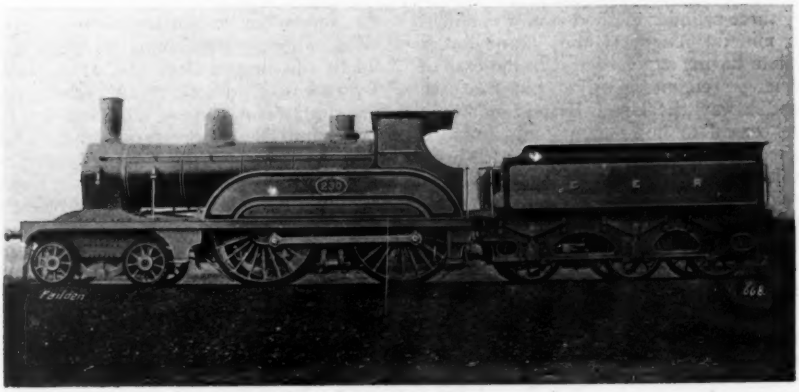


LONDON AND NORTH-WESTERN THREE-CYLINDER COMPOUND GOODS ENGINE, NO. 2,539. F. W. WEBB. CYLINDERS: HIGH-PRESSURE (2), 15×24; LOW-PRESSURE (1), 30×24; COUPLED WHEELS, 4 FT. 3 IN.

It will therefore be necessary only to consider these three surviving types of British compound-locomotives, the two-cylinder (Worsdell-von Borries), the three-cylinder (Webb), and the four-cylinder (Webb).

In the Worsdell-von Borries compounds there are two cylinders, one high pressure and the other low, both placed inside the frame and driving the same crank axle. The valve-chests are placed in the smoke-box above the cylinders. Steam, after being taken from the boiler by the high-pressure cylinder and duly used, is exhausted thence into the low-pressure cylinder, the exhaust being carried round the smoke-box to the low-pressure valve-chest, whence, after doing its work, it is finally discharged into the atmosphere. By means of an intercepting valve, high-pressure steam can be admitted by the driver into the low-pressure cylinder when this is necessary for the purpose of starting. Both valves are controlled by a single handle, and the operation is officially described as follows:—"The two valves are operated by steam, and controlled by one handle. If the engine does not start when the regulator is opened, which will occur when the high-pressure valve covers both its steam ports, the driver pulls the additional small handle, which closes the passage from the receiver to the low-pressure cylinder, and also admits a small amount of steam to the low-pressure steam-chest, so that the two cylinders together develop additional starting power. After one or two strokes of the engine, the exhaust steam from the high-pressure cylinder automatically forces the two valves back to their normal position, and the engine proceeds working compound."

In Mr. Webb's three-cylinder system, the inventor claimed the following advantages:—(1) greater power; (2) economy in consumption of fuel; (3) the whole of the available power of the steam is used; (4) a more even distribution of the strains upon the working parts, and larger



GREAT-EASTERN COMPOUND EXPRESS ENGINE, NO. 230. FIRST BUILT ON THE WORSDELL-VON BORRIES SYSTEM. CYLINDERS HIGH-PRESSURE, 18 IN.; LOW-PRESSURE, 26 IN.; DIAMETER OF DRIVING-WHEELS, 7 FT. 8 IN. CONVERTED.

bearing surfaces for the axles; (5) the same freedom of running as with a single engine, with the same adhesion to the rails as a coupled engine.

Each locomotive virtually comprises two distinct and quasi-independent engines with one boiler and on one frame. The cylinders of the high-pressure engine are attached to the frame-plates midway between the smoke-box and the front pair of driving-wheels, but drive the trailing pair of wheels which are not coupled to the pair next in front. The slide-valves, actuated by Mr. Joy's gear, are underneath the cylinders. The low-pressure engine has one cylinder placed inside the frame, which propels the front pair of driving-wheels by means of a single-throw crank. The action is officially described as follows:—"The steam is conducted from an equilibrium regulator in the dome to a brass T-pipe fixed to the smoke-box tube-plate, and thence by two copper steam-pipes, $\frac{3}{4}$-in. in diameter, running first parallel with the tube-plate, then through the back-plate, which carries the low-pressure cylinder, and between the inside and outside engine frames to the steam-chests of the high-pressure cylinders. The exhaust steam from each of these cylinders is returned in a copper pipe, 5-in. in diameter, running horizontally beneath the high-pressure pipe into the smoke-box. Each pipe then passes through the hot gases round the smoke-box to the opposite side, and enters the steam-chest of the low-pressure cylinder. Thus the high-pressure exhaust steam, at a pressure restricted by means of a safety-valve to 80 lbs. per square inch, becomes superheated and dried in these pipes by the waste gases of the smoke-box, while the large capacity of the pipes obviates the necessity for a separate steam-receiver. The final exhaust escapes through the back of the low-pressure slide-valve and steam-chest cover into the blast-pipe, and thence to the chimney in the usual way, the only difference being that the number of exhaust beats for urging the fire is reduced to half, compared with an ordinary engine. One of the pipes forming the receiver in the smoke-box is fitted with a valve similar in construction to the regulator, and opening direct into the blast-pipe, which allows the driver to turn the exhaust steam directly from the high-pressure cylinders into the chimney, a course which may be useful in starting, should the low-pressure crank stand on a dead centre.

"An ordinary screw-valve, placed on the side of the smoke-box, enables the driver to admit a small amount of boiler high-pressure steam into the receiver to start the low-pressure crank when it is not on a dead point.

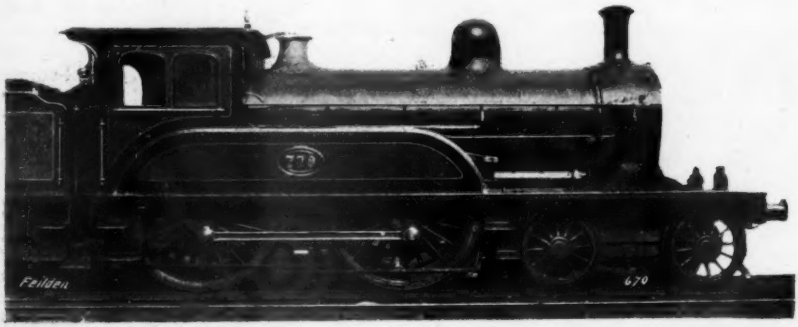
"These two starting-valves are ingeniously arranged to work with two distinct motions of one handle, the arrangement being such that the first may be locked open to the chimney while the second remains shut. Balanced side-valves are used in all three engines. The low-pressure cylinder cocks are fitted with safety-valves to prevent the pressure rising above 80 lbs. per square inch, and an automatic air-valve is placed in the receiver to open when the engine is running without steam, in order to destroy the vacuum which would otherwise form in the receiver and act as a retarding force in the large cylinder.

"The reversing-gear consists of a hand-wheel and screw connected to the middle of a short lever, the ends of which are joined by long stiff rods to the high-pressure and low-pressure reversing shaft. Thus the two high-pressure and the one low-pressure engines can be reversed together, or by a simple means of locking either high-pressure or low-pressure, the other gear can be adjusted by the hand reversing wheel to the required amount of 'notching up' or steam cut-off required."

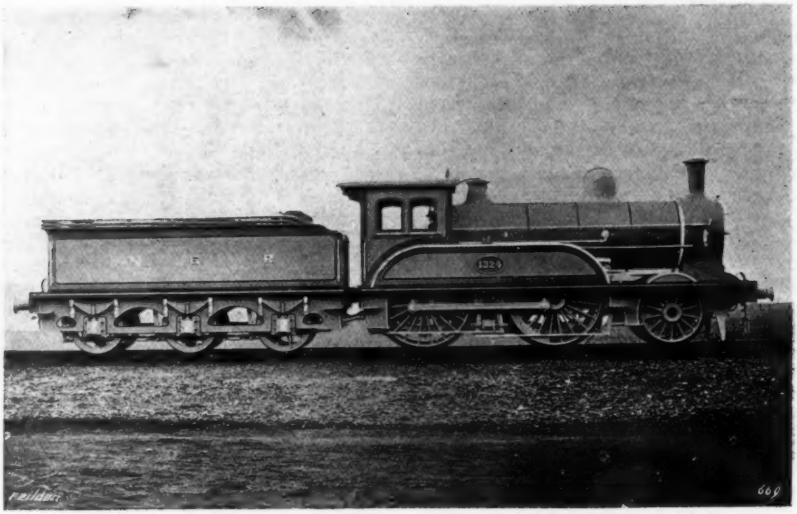
Subsequently Mr. Webb discontinued the use of the Joy valve-gear for the low-pressure cylinders and substituted the shifting eccentric, while the arrangement of the pipes which convey the steam from the high-pressure to the low-pressure cylinders has undergone some modification.

In Mr. Webb's latest "Greater Britain" type of three-cylinder express compounds, the high-pressure and low-pressure valves all are worked by rocking levers, the low-pressure valve having a single eccentric. The special feature of this class is that the boiler, 18 ft. 6 in. long, is divided into two parts by an intermediate combustion-chamber 2 ft. 8⅛ in. in length, which is situated 5 ft. 10 in. from the fire-box and has a hopper underneath for the discharge of ashes. The total heating surface is 1,541 sq. ft., and the grate area 20·5 sq. ft. The steam pressure is 175 lbs., and the weight of the engine loaded is 52 tons 2 cwt.

Mr. Webb's four-cylinder compound, first produced in 1897, differs very largely from his three-cylinder type. In the first place all the four cylinders are placed abreast, the two low-pressure cylinders being inside the frames and under the smoke-box, while the two high-pressure cylinders are outside. The latter are 15 in. in diameter and have the Joy valve-gear, while the valves of the 20½-in. low-pressure cylinders are worked by simple levers at the front from those of the high-pressure cylinders. All the cylinders have a piston-stroke of 24 in. and drive the front pair of 7-ft. wheels. The diameter of the low-pressure cylinders has been increased by 1 in. since the pioneer of the class "Black Prince" first came out, and is now 20½ in. for all of the class, 20 in number. In the



COMPOUND EXPRESS ENGINE (WORSDELL-VON BORRIES SYSTEM), NORTH-EASTERN RAILWAY, NO. 779. CYLINDERS: HIGH-PRESSURE, 18 IN.; LOW-PRESSURE, 26 IN.; STROKE, 24 IN.; DIAMETER OF DRIVING-WHEELS, 6 FT. 8 IN.



FIRST COMPOUND EXPRESS ENGINE ON NORTH-EASTERN RAILWAY, NO. 1,324. WORSDELL-VON BORRIES SYSTEM. CYLINDERS: HIGH-PRESSURE, 18 IN.; LOW-PRESSURE, 26 IN.; PISTON-STROKE, 24 IN.; DIAMETER OF DRIVING-WHEELS, 6 FT. 8 IN.

second place the two pairs of 7-ft. wheels are coupled instead of being left wholly independent, as in the three-cylinder type. This is an unquestionable improvement, notwithstanding the drawbacks which attach to coupling. Long and close observation of the working of the three-cylinder locomotives has left no doubt in my mind that at times there is a lack of synchronism in the operation of the high-pressure and low-pressure engines, which, being mainly independent of one another, do fail now and then to pull together absolutely—to "keep step," as it were—and so while they are struggling to get into step again there is some loss of efficiency. I am quite well aware that this tendency is theoretically corrected. I am convinced, nevertheless, that in practice it does to some extent remain. I admit the drawbacks of coupling, but the most serious of these—the liability of the side-rods to bend or break—has in a large degree been removed by improved methods of construction, such as the fluting which affords greatly enhanced strength without increased weight. That coupling involves greater friction, and therefore more resistance, may at once be admitted, but the augmented power may fairly be set against that drawback even though this may include heavier wear-and-tear and repairs. Another advantage gained in the four-cylinder engine is the better balancing of the reciprocating and revolving parts. That is in itself a very important matter. The weight of an engine of this class in working order is 54 tons 8 cwt.

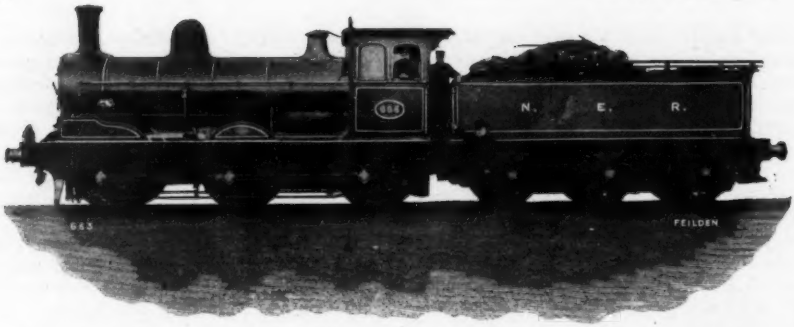
While these are now the standard passenger engines of the London and North-Western, the standard goods engine is of a type not seen elsewhere either in Great Britain or abroad. It is eight-coupled with 4 ft. 3 in. wheels, and has two 15-in. outside high-pressure cylinders and one 30-in. inside low-pressure cylinder, all three driving the same—the second—axle, with a 24-in. piston-stroke, and link-motion valve-gear to the high-pressure, the low-pressure having Mr. Webb's single eccentric. The boiler is of great length (15 ft. 6 in.), but has no combustion-chamber like that of the "Greater Britain" class. The heating surface is 1,489 sq. ft., and grate area 20·5 sq. ft. The total weight in working order is 49 tons 5 cwt.

These massive and powerful engines are doing excellent work, and by taking largely increased loads have materially relieved the heavy pressure of traffic on that crowded system.

So much for the methods of compounding employed in Great Britain. Turning next to France, it may be said at once that while the compound principle is adopted to an extent enormously greater than in Great Britain, there is virtually but one system in use—that devised by M. de Glehn, the very able Administrateur-Directeur of the Société Alsacienne de Constructions Mécaniques, which has its vast ateliers at Belfort and Mulhausen respectively, that is to say on *both* sides of the Franco-German frontier, and accordingly supplies locomotives in large numbers to Germany, Austria and Switzerland, as well as to all the main lines of France.

Differing in a few minor details and dimensions, to suit the various lines on which they run, these engines are identical as to their main principles, proportions, arrangements and central idea. They have now been adopted as the standard type on *every main line in France*. It was on the Chemin de Fer du Nord that the merits of M. de Glehn's design first found recognition, and since then M. du Bousquet, the admirable Ingénieur-en-Chef-de-la-Traction of that important railway has collaborated most cordially with M. de Glehn in jointly producing a locomotive that shall best fulfil the special requirements of the varied traffic carried by that line. This full and generous recognition by M. du Bousquet of the excellence of M. de Glehn's design is all the more honourable to him as he himself, being an engineer of distinguished capacity, might fairly have preferred to place an engine of his own design upon the road over whose mechanical department he then had newly come to preside. But M. du Bousquet saw at once how excellent was the engine which M. de Glehn had devised, and he adopted it forthwith. Nay, more than this, he is always most anxious to have it thoroughly known and recognised who was the designer of the splendid engines which have made the French Northern line so famous. M. du Bousquet is more than merely a great engineer; he is a most generous and honourable *man!* Nor does M. de Glehn fall at all short in this generosity and honourable feeling. He on his part is always most eager to impress it upon those who communicate with him respecting his engines, that but for the hearty and valuable co-operation and collaboration of M. du Bousquet he could not have won the general acceptance and success which his engines have secured, for M. du Bousquet not merely adopted them, but also was assiduous in suggesting every

NORTH-EASTERN TWO-CYLINDER COMPOUND EXPRESS ENGINE, NO. 1,517. WORSDELL-VON BORRIES. CYLINDERS: HIGH-PRESSURE (1), 20×24; LOW-PRESSURE (1), 28×24; DRIVING-WHEELS, 7 FT. 7½ IN.



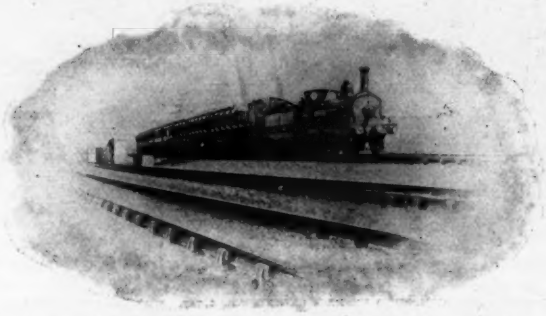
NORTH-EASTERN TWO-CYLINDER COMPOUND GOODS ENGINE, NO. 616. WORSDELL-VON BORRIES. CYLINDERS: HIGH-PRESSURE (1), 18×24; LOW-PRESSURE (1), 26×24; COUPLED-WHEELS, 5 FT.

improvement in detail which he believed would render their success more certain and general. It is very pleasant to find such generous sentiments and acts and such an absence of professional jealousy. And the practical result of this co-operation has been of enormous value to the whole of France.

The type soon found acceptance also on the Midi and P. L. M. lines. Later, it was adopted on the Etat and Ouest and Paris-Orléans Railways, and finally the Chemin de Fer de l'Est has also followed suit. This last adhesion is the more noteworthy inasmuch as M. Salomon, the able Chief Mechanical Engineer, had already established a class of very powerful and efficient engines for the express duty, their peculiarity being the double-barrelled boiler—or steam drum above the boiler-barrel—known as the Flaman type, which characterised the 40 locomotives—Nos. 801 to 840. These have done, and still do, excellent work, but an exhaustive series of comparative trials proved the substantial superiority of the de Glehn compounds. As M. Salomon put it to me: His own engines could do many things as well as the compounds, but in the "démarrage" or starting, the compounds proved themselves so greatly superior that this advantage alone justified their adoption. And now they are universal in France as the standard main-line type.

C. Rous-Marten

(To be concluded in the next issue.)



A portrait and biography of Mr. ROUS-MARTEN appeared on page 19, Vol. I.

Carburetted Water Gas.

By SAMUEL CUTLER, JUNR., M.I.MECH.E.

SAMUEL CUTLER, JUNR., Partner in the firm of Messrs. S. Cutler and Sons, Contracting Gas Engineers, Millwall, London, was educated at Clifton College and the Technical University, Mittweida, Germany. As a member of a firm that has a world-wide reputation in gasworks construction he is well known in English and Continental gas circles. He has given especial attention to the development of the Carburetted Water Gas industry, and in this connection has visited many of the principal gasworks in the United States and Canada.

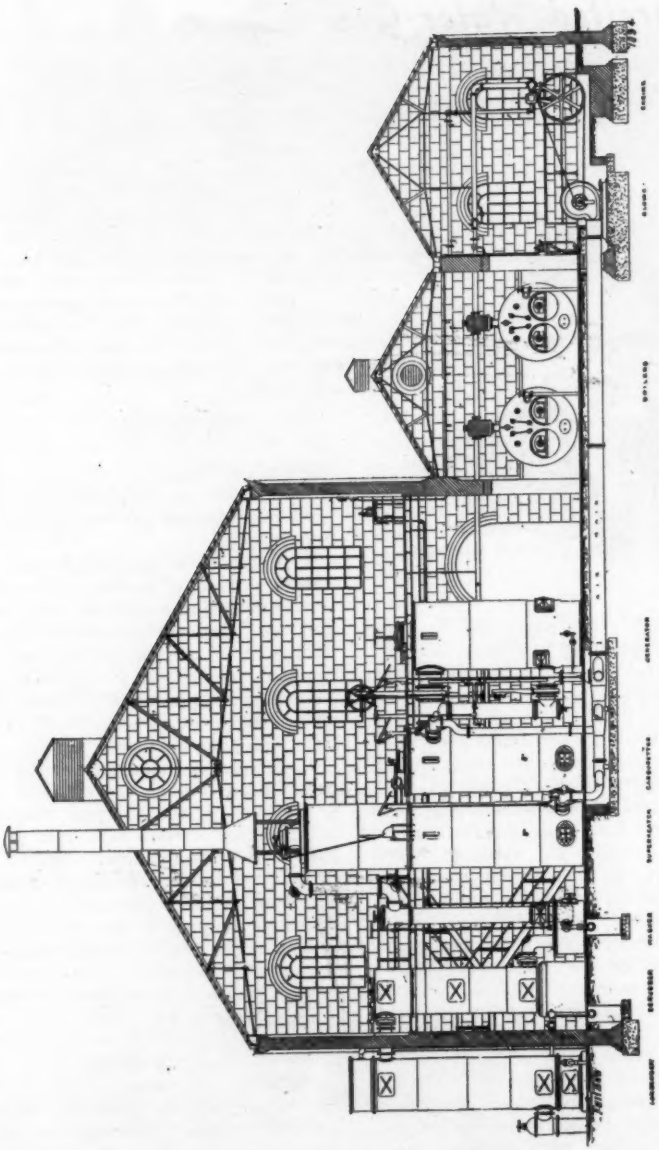
CARBURETTED water gas is now manufactured at over 60 important gasworks in the United Kingdom, and the number of installations is rapidly increasing. Plants are at work or under construction capable of producing over 100 million cubic feet of gas per diem, a quantity equal to two-thirds of London's maximum daily consumption, and four times greater than is required to supply the whole of Manchester. Yet, so recently as ten years ago, no gas of this kind was produced in England, and the purpose of the present article is to briefly describe the method of its production, and to refer to some of the more salient points which have contributed to its rapid progress and general success.

In most towns and districts of the United Kingdom the supply of illuminating gas is a monopoly granted by Parliament to statutory companies, corporations, or local authorities, each having a prescribed district to supply with gas of a specified illuminating power at a stipulated price. The nature of the gas to be furnished is not usually further defined, but until recently coal gas was almost invariably supplied.

Coal gas, as is generally known, is the volatile product of the destructive distillation of bituminous coal in closed retorts, and its luminosity is derived from the hydro-carbons present in the coal. Carburetted water gas, as its name implies, is "water gas" carburetted or enriched with extraneous hydro-carbons, usually derived from petroleum distillates.

Water gas is made by passing superheated steam through incandescent carbon, it consists of about equal volumes of hydrogen and carbon monoxide, and is a combustible non-luminous gas. It is carburetted by the admixture of gasified petroleum, which imparts to it the required degree of luminosity, and the combined gases are then passed through heated fire-brick chambers termed "fixers" or "superheaters" to give permanence and uniformity to their illuminating power. The whole operation is carried out in closed vessels, and is rapid and convenient.

An important feature of the process is the few operatives required, compared with the number necessary in coal-gas production, and the comparatively light and cleanly nature of the duties to be performed. Perhaps the best proof of



A MODERN CARBURETTED WATER-GAS PLANT.

THE OPERATING FLOOR AT SOUTHALL.

this is the fact that where such plants have been installed the coal-gas operatives are generally anxious to be transferred to the water-gas staff.

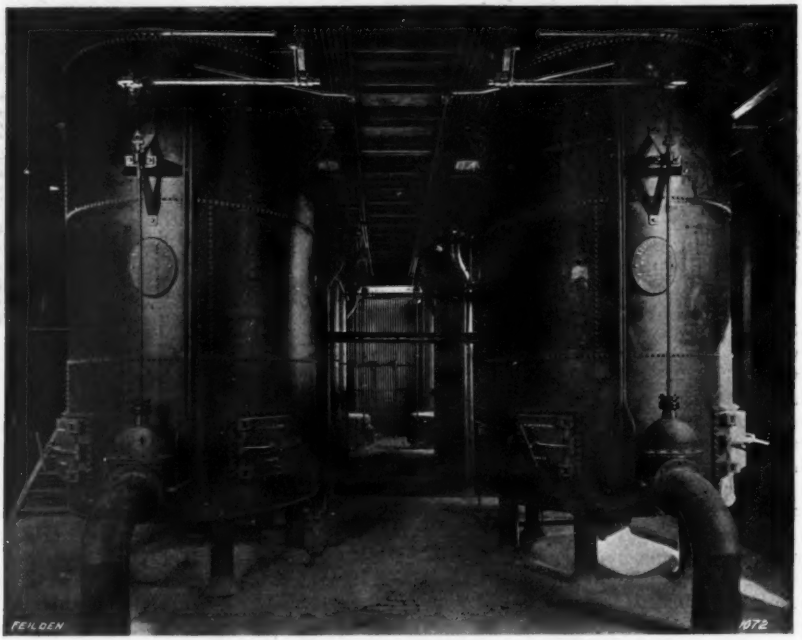
Carburetted water gas has had a long and chequered history. Its potentialities were early recognised by English gas engineers, but the impossibility of securing a suitable carburetting material long delayed its successful utilisation. Many enrichers were tried, but the difficulty was never really surmounted until the discovery of petroleum oils—which are particularly suitable for the purpose, being rich in the required hydro-carbons, volatile and readily convertible into a permanent gas. The petroleum supply is now drawn from an area wide enough to afford reasonable security, that oil of a sufficiently uniform character will be continuously obtainable at reasonable prices.

To chronicle even briefly the names and methods of all the early investigators is not possible within the limits of the present article, but the patent of John and Thomas Kirkham in 1854 deserves especial notice as introducing the vertical or "cupola" form of generator now almost exclusively adopted; also mention should be made of the useful and exhaustive experimental work of Robert Paulson Spice some twenty years later.

The historical side of the question is interesting reading, and an excellent review of the earlier processes will be found in "The Chemistry of Illuminating Gas" by Norton Humphreys, a gentleman whose writings are familiar on both sides of the Atlantic.

In the United States the advantage of utilising petroleum for gas-making purposes was early recognised, and numerous types of apparatus were devised and tried with varying success. Many of these are now entirely obsolete, the "survival of the fittest" being represented by the "Lowe" plant which is now almost exclusively adopted as being the most economical, efficient, and convenient.

The "Lowe" type of plant largely predominates in England, and was first introduced here by the Gas Light and Coke Company, of London, on the recommendation of their Engineer, Mr. G. C. Trewby, who had inspected the various systems available. Some parts of this first plant were imported from America, and others were constructed by Messrs. S. Cutler & Sons.



GROUND FLOOR VIEW OF SOUTHALL PLANT.

The illustration opposite shows a sectional view of the generating vessels of a Carburetted Water Gas Plant. The exterior casings are of steel, and have a diameter of from 4 ft. to 10 ft., according to the output of gas required.

The first vessel or generator is lined with a special description of firebrick to withstand very high temperatures and contains the coke fuel bed, usually 5 to 6 ft. deep. It is provided with a charging door for the renewal of fuel, clinkering doors, and ash hopper.

The second vessel or carburetter is also lined with firebrick and has its interior stacked with small rectangular fire blocks placed checker fashion to form narrow conduits, through which the gases pass in close contact with the heated surfaces. The carburetting oil is admitted at the top of this vessel in the form of a fine spray, and becomes vaporised by contact with the heated checker blocks.

The third vessel or superheater is lined and stacked in a similar way to the carburetter, and has at its upper extremity a stack valve, by means of which communication can be made with the chimney. Each of these three vessels has an air inlet with a regulating valve, and is supplied from a general air blast main, in which a pressure of 10 in. to 12 in.

water column is maintained by means of a high-speed fan.

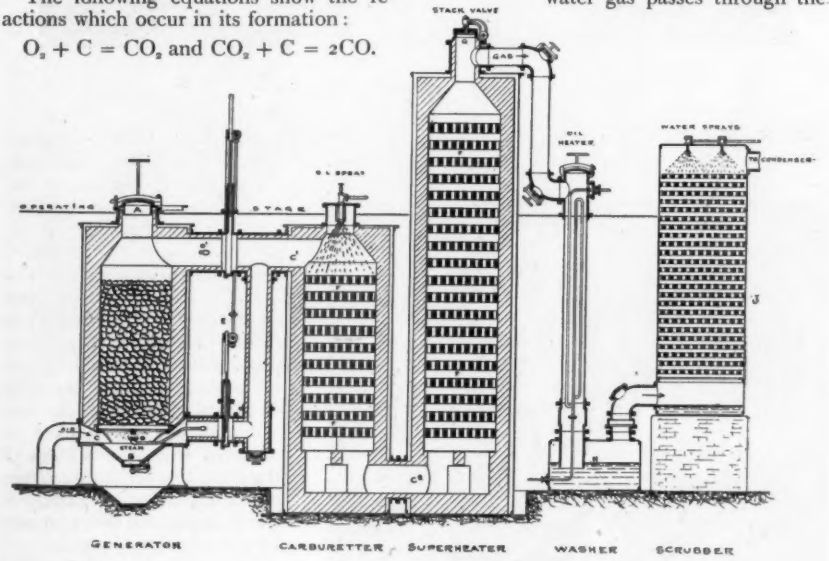
Sight glasses are fixed at various points to allow the operator to observe the interior condition of the hot vessels as occasion requires, and a battery of pressure gauges indicates the gas, air, steam, and oil pressures at all times.

In the operation of gas-making the primary air is admitted at the bottom of the generator for a period of three or four minutes, during which time the fuel is raised to a high state of incandescence, and large volumes of producer gas are formed. This gas consists chiefly of nitrogen and carbon monoxide, the nitrogen is derived from the primary air, the oxygen of which combines with the carbon of the fuel in such a manner that 25 to 30 per cent. of the ultimate product is almost wholly carbon monoxide.

The following equations show the reactions which occur in its formation:

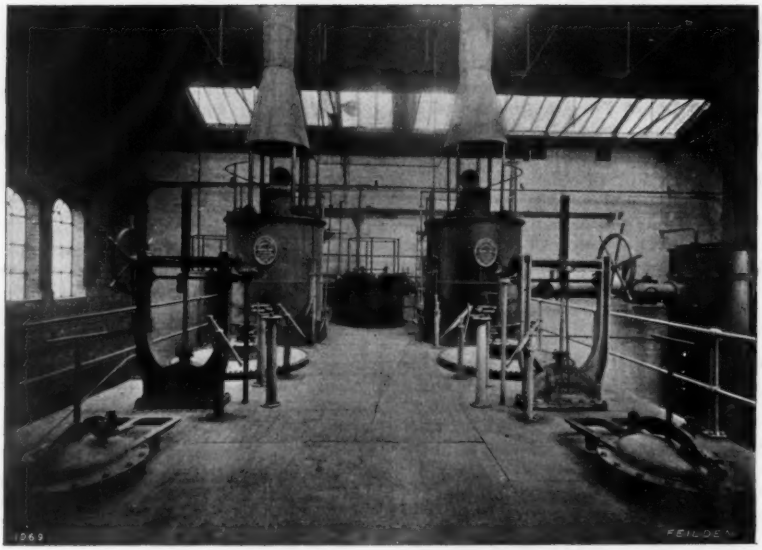
$$O_2 + C = CO_2 \text{ and } CO_2 + C = 2CO.$$

This producer gas passes into the succeeding vessels, where, by the admission of secondary air, it is burnt, the heat being absorbed by the firebrick checker work, which has to be maintained at a bright cherry red. The stack valve on the superheater is meanwhile open, and the products of combustion pass into the chimney. At the end of this operation, termed the "blow," the coke fuel in the generator should have attained a temperature of over 2,000 degrees Fahr. and therefore be in condition for making water gas. The air valves are accordingly closed, and steam at a pressure of 100 lbs. per square inch is admitted below the heated fuel, the stack valve is closed, oil is sprayed into the carburetter, and the resulting carburetted water gas passes through the



SECTION OF A CARBURETTED WATER-GAS PLANT.

A Fuel charging door on generator.
B Ash door on generator.
C Air blast supply to generator.
*C*¹ Do. do carburetter.
*C*² Do. do. superheater.
D Steam inlet for up runs.
*D*¹ Do. down runs.
E Coupled reversing valves for up and down runs.
F Checker fire-bricks in carburetter and superheater.
G Stack valve operated from stage by lever.
H Water seal to prevent gas returning when stack valve is open.
J Wood grids in scrubber.

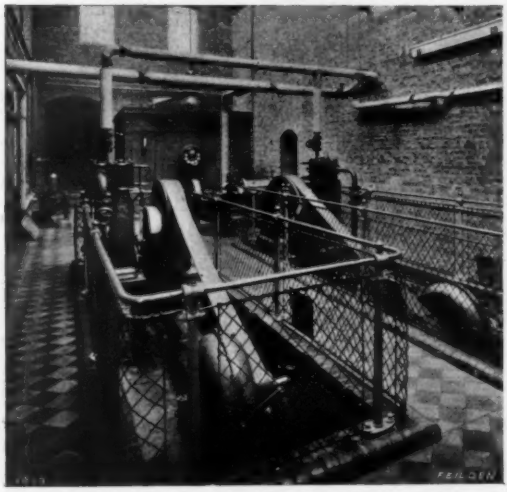


THE OPERATING FLOOR AT FOLKESTONE.

duct at the head of the superheater into the wash box, and thence to the purifying vessels and gas-holders. This gas-making period is termed the "run," and lasts six or seven minutes, at the end of which time the temperature of the fuel in the generator will be decreased several hundred degrees. The "run" is then "taken off" and succeeded by the "blow" as before, and this alternation proceeds continuously, except for a short interval every six or eight hours, when any accumulation of clinker is removed from the bottom of the generator fire. The action of the steam on the carbon of the incandescent fuel is shown by the following equation:

$$C + H_2O = CO + H_2$$

The product of the action consists, therefore, of equal volumes of carbon monoxide and hydrogen, and this mixture constitutes the water gas, which is enriched with oil



THE ENGINE ROOM AT HARROW.

vapours in the carburetter, as already described.

The fuel is charged into the generator by means of hopper wagons at regular intervals, and hot coke direct from the coal-gas retorts may be used with advantage. The intermittent nature of the process renders it important that the operator should be punctual and alert, but in a well-designed plant the various valves are adjacent and easy to manipulate, and the change over from "blow" to "run" or *vice versa* is accomplished in a few seconds.

ENGINE ROOM AT HORSHAM.

It is most essential that dry high-pressure steam and a hot generator should always be maintained, as with too low a temperature in the generators the carbon consumed is not wholly converted into carbon monoxide, but forms some carbonic acid, until a point is reached at which carbonic acid is formed to the entire exclusion of carbon monoxide, as shown by the equation:

$$C + 2H_2O = CO_2 + 2H_2$$

As carbonic acid is an incombustible gas which reduces the temperature and luminosity of the flames of other gases when mixed with them, it is most desirable to restrict the formation of this impurity, and, although it cannot be wholly avoided, the proportion made should not exceed 3 or 4 per cent. This may afterwards be removed by passing the gas through lime, or its depreciative effect may be compensated for by the use of a little additional carburetting material.

The temperature necessary in the carburetter and superheater for volatilising and fixing the oil is much less than that required in the generator, and variations are sometimes desirable to suit particular descriptions of oil, but such adjustment may be made with ease and precision by suitably regulating the supply of secondary air. Too great a heat produces lamp-black, and too low a heat an undue proportion of tar. The object of the operator should be to avoid both extremes and to produce neither

lamp-black nor an excess of tar. It is of course impossible in any process in which mineral oils or coal are gasified to avoid the production of a certain amount of tar owing to the difference in chemical composition of the gas and the oil or coal, but in carburetted water-gas manufacture the ready means that exist of controlling the temperatures make it possible to reduce this residual to a minimum.

The absence of residuals is a striking feature of the carburetted water gas process, there being only a small quantity of ash and oil tar in this category, while in coal-gas manufacture the residuals amount to some 70 per cent. of the weight of coal used and include items of fluctuating and uncertain value.

The following analyses of gas and tar produced in plants erected by the writer's firm were recently made by Mr. W. Atkinson Butterfield. The proportion of the various constituents will vary according to the illuminating power of the gas, which in this case was about 23 candle-power.

Mean Composition of Unpurified Carburetted Water Gas taken from one of Messrs. Cutler's Plants, January, 1900.

	Percentage by volume.
Hydrogen (H_2)	37·60
Carbonic Oxide (C O) (Carbon monoxide)	32·50
Marsh gas (C H_4) (Methane)	11·60
Illuminating Hydrocarbons (C_n H_m) (chiefly ethylene and benzene) ...	10·00
Nitrogen (N_2)	4·52
Carbonic Acid (C O_2), (Carbon dioxide)	3·67
Sulphuretted Hydrogen (S H_2) (=72 grains per 100 cubic feet of gas) ...	0·115
Oxygen (O_2)	trace
	100·00

The proportion of sulphur impurities present in the crude carburetted water gas will vary somewhat, according to the description of coke and oil used in its manufacture; but the percentage is invariably far below what is present in ordinary coal-gas, and purification is therefore more cheaply and simply effected.

Composition of Separated Tar from one of Messrs. Cutler's Plants, April, 1899.

The specific gravity of the tar at 60 degrees Fahr. was 1·089, and on distillation it yielded the following products:

	Specific gravity.	Percentage by weight.
Light oils collected between 171° and 338° Fahr. ...	0·8905	5·72
Middle oils collected between 338° and 518° Fahr. ...	0·9920	27·30
Heavy oils collected between 518° and 662° Fahr. ...	1·0620	28·28
Pitch	1·2750	33·88
Water	1·0000	4·82
		100·00

Tests of some average Carburetting Oils as used in various Plants erected by Messrs. Cutler & Sons.

	Sample 1.	Sample 2.	Sample 3.
Specific gravity at 60° Fah.	·8720	·8767	·8657
Flash point by close test ...	233° F.	216° F.	196° F.
Temperature at which distillation began to proceed freely	480° F.	446° F.	410° F.
Percentage, by volume, of the oil distilled below 662° Fah.	81	93	87
Temperature at which distillation entirely ceased	735° F.	707° F.	707° F.
Percentage, by weight, of solid residue left after distillation	0·450	0·190	0·230
Percentage of water, by weight	0·100	none	none

It is important to effectually isolate the air mains from the gas producers during the gas-making periods, so as to avoid the formation of explosive mixtures, and to this end the writer's firm interlock the steam and air valves so that they cannot be wrongly manipulated. Normally, during gas-making all the air valves are closed, but if in an uninterlocked plant the operator inadvertently opens one of these valves before turning off the steam, the gas will probably enter the air main and may form an explosive mixture, which, if fired from the hot vessels, will cause damage. This is a matter well known to

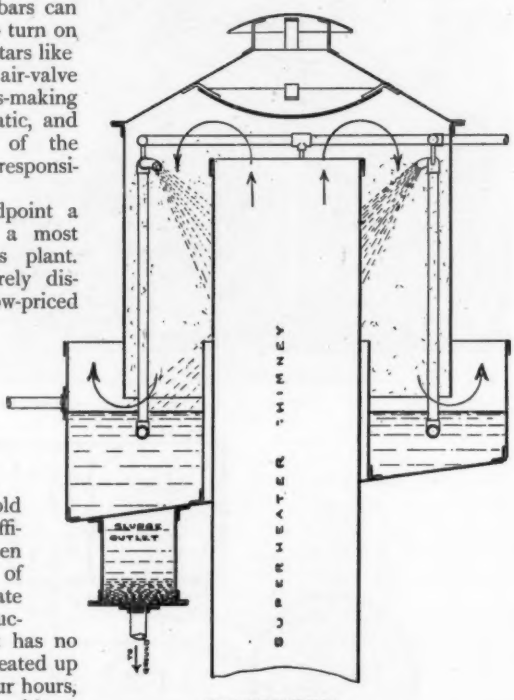
users of water-gas apparatus, but apart from plants erected by the writer's firm interlocking is rare. The system adopted by Messrs. Cutler, and applied to all their plants, consists primarily of a series of cottar bars (carried on friction rollers under the operating floor), which are projected into slots in the air-valve spindles by the action of turning on the steam to the generator. Thus, until all the air valves are closed, and the cottar bars can enter the slots, it is impossible to turn on steam and make gas, and the cottars like wise prevent the opening of any air-valve until steam is turned off and gas-making has ceased. The gear is automatic, and does not increase the work of the operator, while it relieves him of responsibility.

From a gas manager's standpoint a carburetted water-gas plant is a most useful auxiliary to a coal-gas plant. Expensive cannel coal is entirely dispensed with, and variable and low-priced coals can be used, the quality of the gas being readily adjusted by the use of more or less oil in the carburetted water gas. The price and stock of coke becomes controllable, a portion being used profitably in the manufacture of water gas, and the remainder sold at enhanced prices. Labour difficulties are decreased, as fewer men are required, and any workman of ordinary intelligence can operate the plant after a few days' instruction. As an emergency plant it has no equal, for a set of vessels can be heated up and put to full work in three or four hours, and can be let down again without deterioration—a quite impossible condition for any description of coal-gas producer.

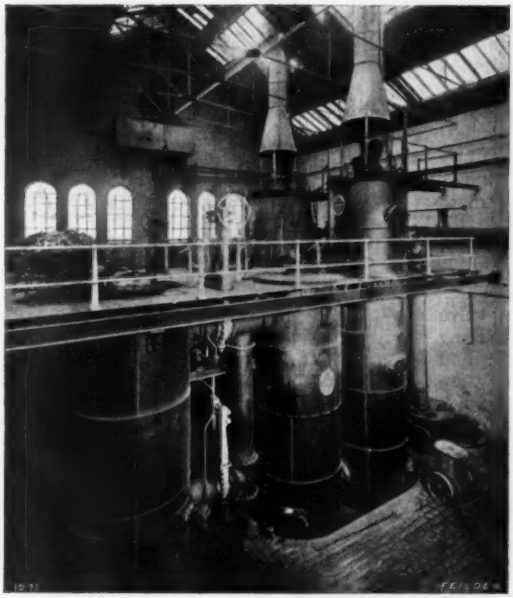
This facility of production reduces the necessity for the large storage otherwise imperative in districts subject to sudden demands, and the significance of this will be apparent when it is stated that 25,000*l.* is by no means an unusual figure for a storage holder and tank suitable for a large industrial town.

Although the original introduction of carburetted water gas into England was due in a large degree to the difficulty of obtaining cannel coal at a reasonable price, its many merits, other than that of an enricher, are now appreciated, and less surprise is felt that 70 per cent. of the whole of the gas output of the United States is produced by this process.

There are but few points in carburetted water-gas manufacture that can cause nuisance or difficulty, but one or two matters should be mentioned in this connection. During the "blow" fine coke dust is frequently carried through the vessels with the air blast, and is liable to deposit upon surrounding property. In a large or isolated works this is of no importance, but under some circumstances it may cause nuisance. A case

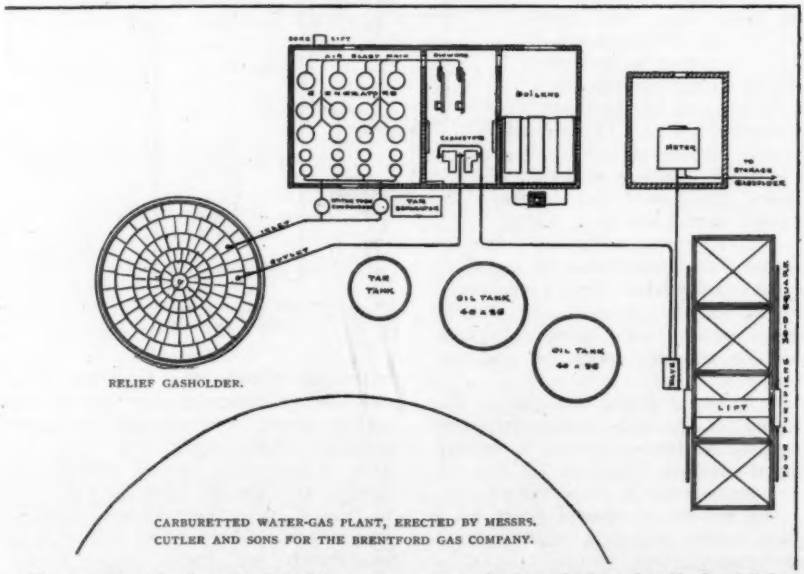


DUST INTERCEPTOR.
(CUTLER'S PATENT.)



THE GENERATING PLANT AT FOLKESTONE.

of this kind arose in connection with a large plant erected by the writer's firm in a provincial town and caused some temporary concern, but the difficulty was entirely overcome by adding dust interceptors of the design shown on p. 385 to the superheater chimneys, and similar ones have since been fitted with every success at other places. The dust is precipitated by means of a series of water or steam sprays, and forms a sludge which is readily withdrawn at ground level through suitable connections. Another matter that has engaged a good deal of attention is the separation of water from the residual tar; the small difference in their specific gravities renders the operation more difficult than is the case with the heavier coal-gas tar, but



RELIEF GASHOLDER.

CARBURETTED WATER-GAS PLANT, ERECTED BY MESSRS. CUTLER AND SONS FOR THE BRENTFORD GAS COMPANY.

The above illustration shows the whole of the apparatus necessary for the production and purification of Carburetted Water-Gas. The gas passes through the various vessels in the following order:—producers, carburetters, superheaters, washers, scrubbers, condensers, relief gasholder, exhausters, purifiers, meter, storage gasholder. The relief gasholder is interposed between the condensers and exhausters to temporarily store the varying and intermittent volume of gas discharged from the producers and deliver it in constant quantity to the exhausting and purifying plant.

"THE OLD."

there is nothing insuperable about it if a suitable separator is provided.

The last, and in some respects the most important aspect of the carburetted water-gas question is the composition of the gas and its suitability for the various purposes to which illuminating gas is now applied. Water gas *per se* obtained considerable notoriety in the eighties in consequence of the proceedings of certain well-advertised companies, and it is probable that the public do not appreciate the great difference between the gas then exploited and the illuminant which is now under consideration. It may, therefore, be well to explain that the water gas of these companies was uncarburetted, inodorous, and non-luminous, and when used for lighting purposes it had to be burnt under magnesium or other mantles, whereas the carburetted water gas of the present day is as luminous and odorous as ordinary coal gas. The important point of difference between carburetted water gas and coal gas is only perceptible by analysis, and consists in the former containing a much larger proportion of carbon monoxide than the latter, the proportion being about 4 to 1.

On the initiative of some prominent medical men, the Home Office early in 1898 appointed a Departmental Committee to investigate the probable effects of an extended use of carburetted water gas, and a good deal of expert evidence was collected. The Committee recognised the utility of the process, especially for emergencies, but reported in favour of a somewhat stringent limitation of the percentage allowed to be supplied for illuminating purposes. No legislation has yet ensued. The American system of supplying undiluted water gas is, however, not likely to be followed in England, as it is necessary to make at least 25 per cent. of coal gas to produce the coke re-

"THE NEW."

quired to make the remaining 75 per cent. of carburetted water gas. Also, as coke is a marketable commodity that helps to swell the revenue of gas concerns, the output is not likely to be reduced to the extent of leaving no saleable surplus. In this respect, English practice will naturally diverge from American, as in the United States anthracite coal is abundant, and is used for most purposes to which gas coke is applied in England. A natural limitation therefore exists, and taking all these matters into consideration it is unlikely that English gas companies will desire to make any excessive use of carburetted water gas, as they will find their interests best served by using a moderate proportion. The fact that Corporations such as Birmingham, Manchester, Halifax, and Leicester, and many other elective representative bodies have adopted the process, and have in several instances extended their initial installations, should prove that it brings advantages to both producer and consumer.

Sam Cutler Jun.

Modern Appliances in Gas Manufacture.

By FLETCHER W. STEVENSON, M.I.C.E.

(Continued from page 292.)

PURIFIERS.

THE impurities present in unpurified gas, and the methods and materials used for their removal having been described, attention may now be directed to the purifier itself, and to improvements effected of late years in its construction, as well as to the appliances now in use for mechanically handling the purifying materials.

The body of the purifier (Fig. 56) is in form of an open cistern constructed of cast-iron plates, a lute for water being cast on to the side plates. It is provided with a moveable cover of sheet iron, having angle and tee-iron framing inside to give the necessary rigidity. The cover has sides usually not less than two feet deep, and these dip into the water in lute, forming a seal and preventing escape of gas. Suitable fastenings are provided to hold the cover down and prevent the pressure of gas underneath from raising it.

Inside the purifier are grids made of wood or iron and supported on tee-iron bearing bars. Upon these grids the purifying material, which is sufficiently porous to allow gas to be forced through, is placed.

The purifiers are generally arranged in a series of four, connected with cast-iron pipes, and controlled by a centre valve by which one purifier can always be shut off during the operation of emptying the fouled material and refilling with fresh.

This is not however universal, various combinations being adopted. A frequent arrangement is to use six purifiers, the first four worked in rotation and doing the bulk of the work, while the last two are used as catches to ensure that foul

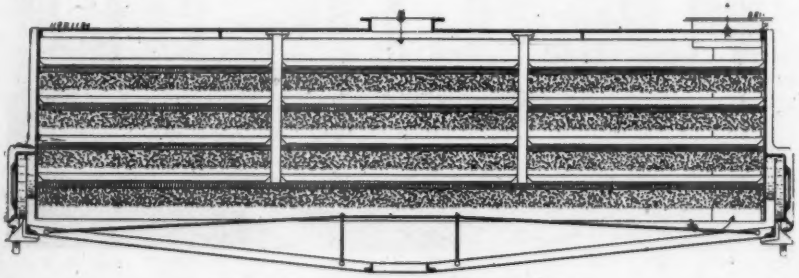


FIG. 56.—SECTION OF ORDINARY TYPE OF PURIFIER.

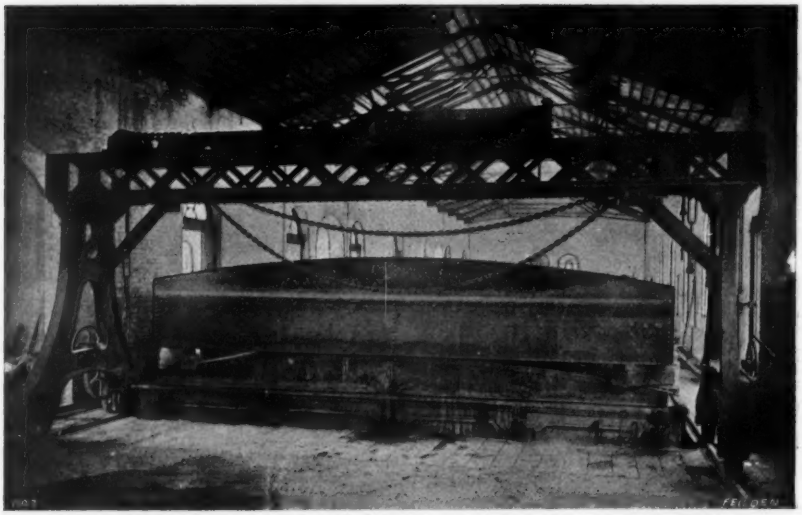


FIG. 57.—CLAPHAM'S "GOLIATH" FOR LIFTING PURIFIER COVER, WEIGHING SIX TONS, BY HYDRAULIC POWER.

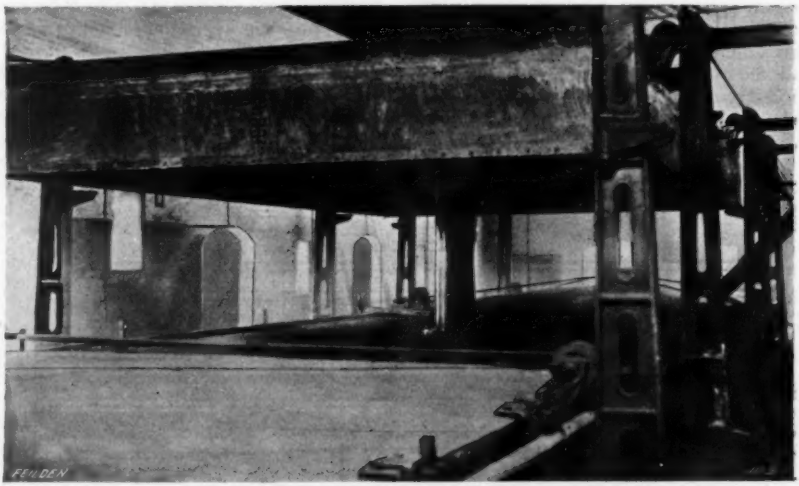


FIG. 58.—PURIFIER COVER, WEIGHING 6½ TONS, RAISED BY HYDRAULIC POWER WITH CENTRAL RAM.

gas shall not at any time pass. Again, six purifiers are sometimes used arranged in couplets, the valves being such that one purifier at a time of each couplet can be shut off.

Each time a purifier is to be emptied and refilled the cover must be lifted high enough to enable men to get under it easily and safely, or after being lifted must be moved away during the operation of changing the material inside. As the size of the purifier increases so do the weight of the cover and the power of the apparatus for lifting it, which, when the size becomes considerable, is a serious addition to cost.

For square purifiers of moderate size, where the cover is lifted at one central point, any form of travelling crane is suitable; but as the size increases, and especially when an oblong shape is employed, it is usual to lift from two points at each side, and in this case two cranes must be used, each lifting from two opposite points simultaneously.

A form frequently adopted for this purpose is a travelling goliath, the lifting being done by hydraulic power (Fig. 57). Such a crane consists of two end standards, each resting on the axle-pins of two grooved wheels running on rails. On the top of the standards are fixed two lattice girders which support the hydraulic cylinders and shafts on which the chain pulleys work. The covers are lifted by two chains, one for either side, each having a lifting hook at one end while the other end is attached to the crosshead fixed on the end of piston rod. The power is applied by a pair of small force-pumps fixed on one of the standards over a small cistern, the capacity of which is a little larger than the cylinder. By an arrangement of taps the water can be sent to either end of the cylinder or back into the supply cistern. A train of gear wheels is attached to one of the grooved wheels on each standard by which the goliath with cover suspended can be travelled.

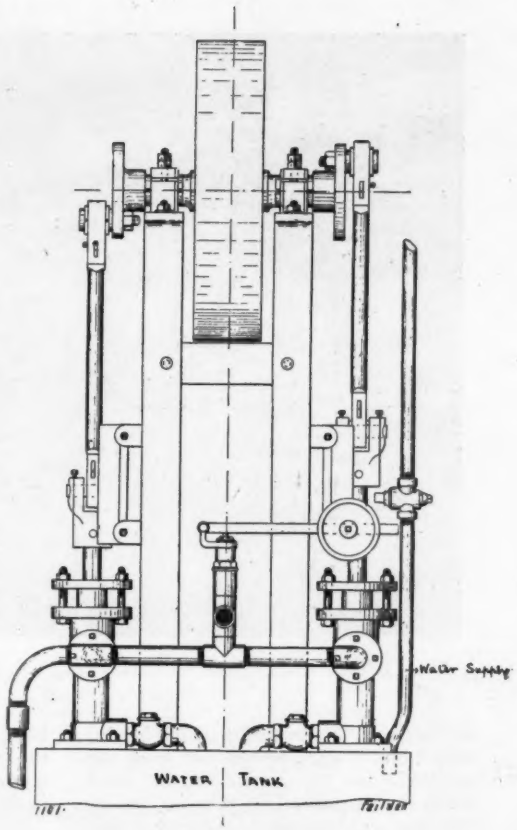


FIG. 59.—ELEVATION OF HYDRAULIC PUMPS FOR RAISING PURIFIER COVERS.

A very convenient method of lifting large covers, is by hydraulic power with a centre ram.

In the case illustrated (Fig. 58), the cover being lifted in this manner is one of a set of six. It is 34 ft. long by 19 ft. 6 in. wide by 3 ft. 2 in. deep, and weighs about 6¼ tons. It is lifted 5 ft. 6 in. clear above the purifier, and is guided in its ascent by four rollers fixed to the top edge of cover, and running against cast-iron

FIG. 60.—VIEW ON TOP OF GREEN'S TYPE OF PURIFIERS AT THE GRIMESTHORPE GASWORKS, SHEFFIELD.

standards. When reaching its full height, hinged brackets are turned out from the standards and the weight of the cover borne by them. The ram is 20 in. diameter, and the hydraulic pressure used 75 lbs. to the square inch. The ram case is utilised to form one of the columns supporting a girder floor on which the purifiers are erected. In cases where hydraulic power of greater pressure is used the ram will be proportionately smaller, but in the case illustrated, as there was no existing installation of hydraulic power, a set of pumps was put down especially for the purpose, driven from an existing line of shaft and worked direct upon the rams without an accumulator; a very small air vessel being found sufficient to prevent shock and ensure the covers rising steadily.

The pumps (Fig. 59) are constructed upon a small cast-iron water tank, a pipe being laid back to it for return water from the rams. An anti-freezing mixture is used, and the water re-used over and over again. The pumps are fitted with 2 in. diameter by 6 in. stroke gun-metal plungers, connected to crossheads working in guides upon frames carrying the shaft and eccentrics. A safety valve and air vessel are fixed upon the outlet of pumps. The whole forms a very compact and cheap arrangement.

A form of purifier which very materially lessens the first cost, and dispenses with large cumbrous covers and costly lifting apparatus, and also permits of more floor space in the house being utilised by the purifiers themselves, is one originally designed by Mr. Henry Green of Preston.

A very complete installation of this type upon a large scale is in use at the Grimesthorpe Station of the Sheffield Gas Company (Figs. 60 and 61).

It consists of six purifiers, each 74 ft. long by 40 ft. wide, arranged in two lines. The three purifiers forming each line are joined together without a break, forming a box 210 ft. long; two cast-iron divisions being inserted to separate one purifier from another.

Instead of each purifier being provided with one large cover, the top is made of cast-iron plates having twelve openings, each 14 ft. 6 in. by 9 ft. 4 in., the covers for these being made of strong steel plates and angles. These are bolted to the top, and a gas-tight joint made with a strip of indiarubber $\frac{1}{16}$ in. thick. The covers are lifted with 30 cwt. chain blocks, having travelling gear and running on a steel joist attached to flanges of the girders forming floor above. The top of the purifiers form a floor upon which the men when changing the purifying material can work and wheel barrows.

The purifiers are connected together with 30 in. diameter pipes and valves.

The cost of these purifiers erected complete was as follows:

	Total Amount.	Amount per sup. ft. of area of purifiers.
	£	s. d.
Purifiers, including connecting pipes, valves, and lifting apparatus for covers	12,228	13 9
Columns and girders forming floor on which purifiers are carried	2,450	2 9
Total cost ...	14,678	16 6

The cost of purifiers of equal area with the usual water lutes and large covers, calculated at the same scale of prices at which the work for the above was carried out, would have been £18,825, or 21*s.* 2*d.* per sup. ft. of area—an increased cost of

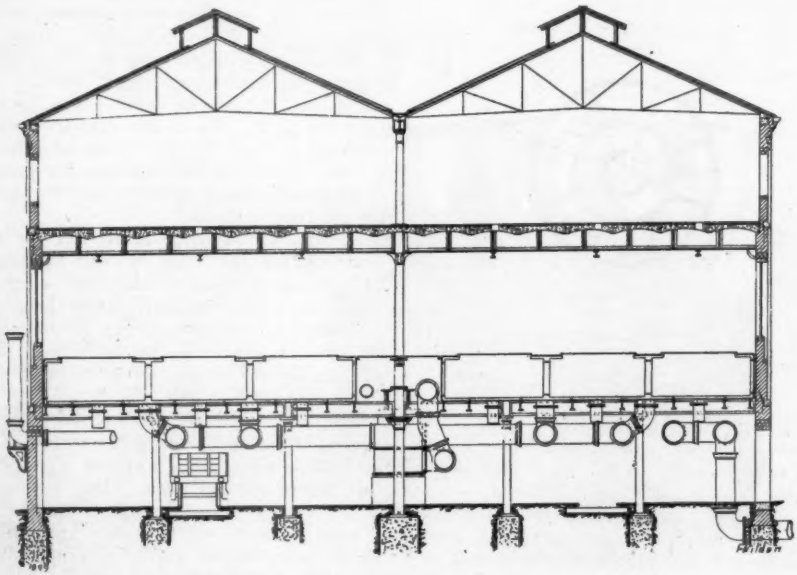


FIG. 61.—SECTION THROUGH PURIFIER HOUSE AT THE GRIMESTHORPE GASWORKS, SHEFFIELD.

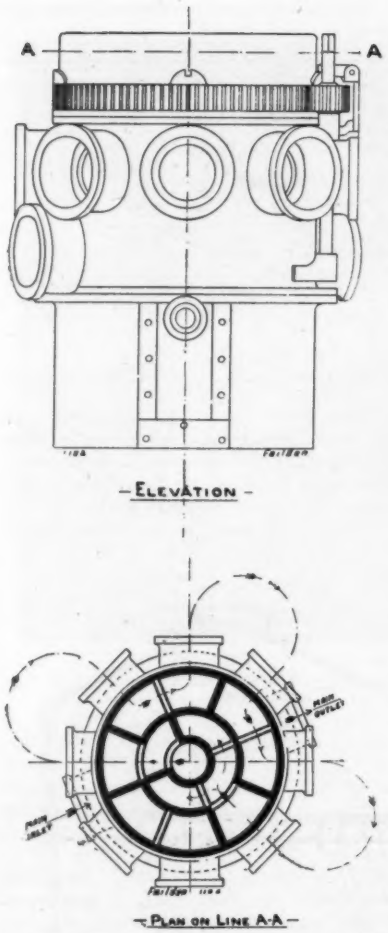


FIG. 62.—DRY-FACED CENTRE VALVE FOR SET OF FOUR PURIFIERS.

£4,147, while the house in which they were placed must have been made larger to permit access to the water lutes on all sides.

The only drawback to the use of Green's type of purifier is the increased time taken, and consequent increased cost of labour, in removing the number of small covers. But the interest on saving in first cost is much more than sufficient to cover this, and the other advantages of the system for large purifiers are numerous.

The house containing these purifiers is a three-storey building. The purifiers are erected upon the first or intermediate floor, while underneath are the valves and pipes, the latter being slung to the girders to give 10 ft. headway from the ground. The oxide of iron is discharged, through openings provided in the bottom of the purifier, on to the ground floor, where after treatment it is filled into small side-tip wagons, raised in a hydraulic lift to the top floor, and there piled in suitable positions for filling a purifier again.

The fresh lime is discharged into the side-tip wagons, raised to the top floor in the lift, and there prepared for use. An opening 12 in. square is provided in this floor over each of the small covers of purifiers, so that when the latter are removed and the purifier is to be refilled, a hose pipe is dropped through the hole and the fresh material shot down. Two sets of railway lines are provided on the ground floor to allow material, when required, to be discharged direct into trucks.

Mr. Thos. Holgate has recently designed, and is now erecting at Halifax, a set of four purifiers of Green's type, each 54 ft. by 38 ft. But in this case they are made 10 ft. deep, the gas being admitted to the centre of the purifier, where it divides and passes up and down through the purifying material.

In this arrangement there will be a tendency for the bulk of gas to pass upwards or downwards inversely, as the upper or lower material offers greater resistance to its passage, and to prevent this Mr. Holgate has placed valves, so that the stream of gas can be checked in either direction.

The cost of these purifiers, including covers, lifting apparatus, grids, valves and connecting pipes, is £6,146, or 15*s.* per sup. ft. of purifier area. But in comparing with the former example at Sheffield, it must remembered that they are some 40 per cent. deeper, and the comparison on a 6 ft. deep basis would be :

Sheffield purifiers 13*s.* 9*d.* per sup. ft.
Halifax ditto 9*s.* 0*d.* ditto.

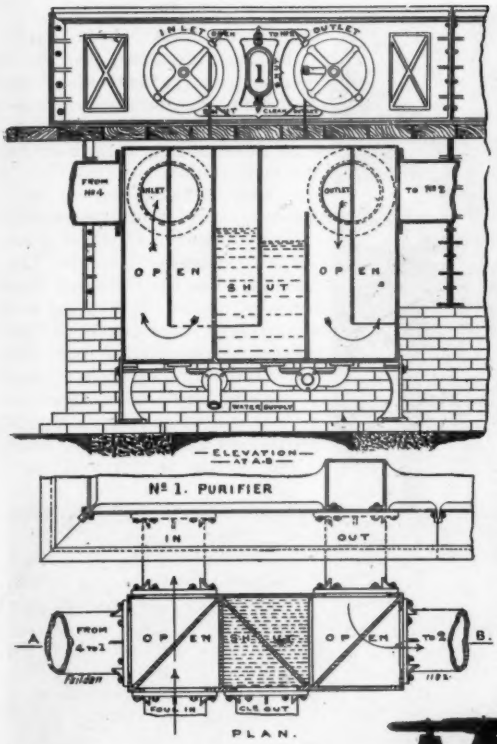


FIG. 63.—CUTLER'S WATER VALVE AS USED FOR WORKING PURIFIERS IN ROTATIVE ORDER, ONE SUCH VALVE REQUIRED FOR EACH PURIFIER.

The stage purifying house has always been considered much more expensive than the arrangement of purifiers, on the ground protected by a light roof, and a stage house has hitherto only been adopted where ground space is limited. But by adopting Green's type of purifiers, this disparity of cost almost disappears. Moreover, in stage houses, the annual cost for labour is considerably reduced, as they give facilities for handling the purifying material very economically.

At the Neepsend Station of the Sheffield Gas Company, where all the purifiers are in stage houses, elevators are used for raising the oxide of iron as it is thrown out of the purifiers to an overhead floor (Figs. 65 and 66) where, after revivification, it is shot down through a hose pipe into the purifier again.

A very complete arrangement of elevators and conveyors for mechanically handling the purifying material, is in use at the Stafford Gas Works. Mr. J. Ferguson Bell, the Engineer, has placed the purifiers on the first floor of a stage house The material, as it is taken out, is shot down on to the ground floor, and when ready again for use is shovelled into a trough conveyor, which carries it to the boot of an elevator, and by the latter it is raised into other conveyors fixed in the roof over the purifiers, and then dropped into the one being filled.

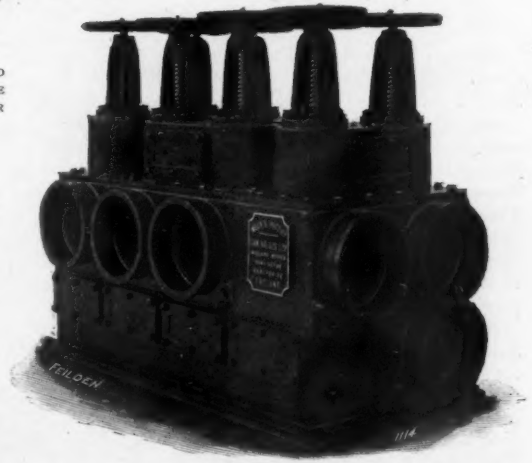


FIG. 64.—WECK'S PATENT CENTRE VALVE, BY WHICH ONE, TWO, THREE, OR FOUR PURIFIERS MAY BE WORKED IN ROTATION. (MANUFACTURED BY C. AND W. WALKER.)

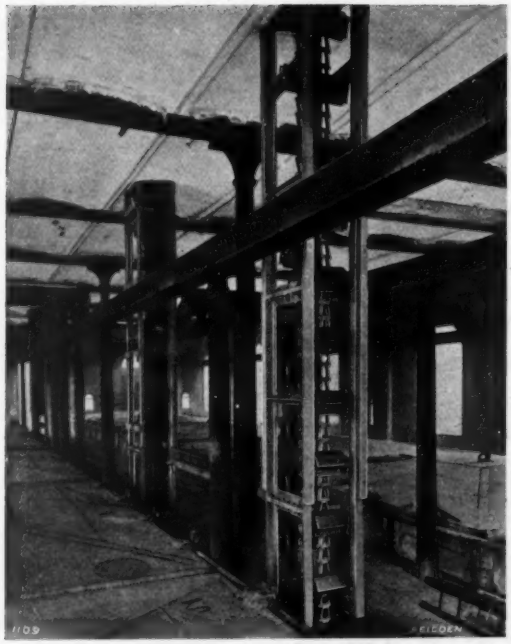


FIG. 65.—ELEVATORS FOR RAISING PURIFYING MATERIAL TO AN UPPER FLOOR AT THE NEEPSEND GASWORKS, SHEFFIELD.

A very economical method of handling the material may be seen at the Nine Elms Station of the Gas Light and Coke Company, where the house is built over two canal docks, and the spent material is dropped direct from the purifiers into barges, which are then taken down the Thames to the dumping ground. The fresh material is also brought up by barges and raised with hydraulic cranes on to the floor above the purifiers, and there prepared for use.

At the East Greenwich Station of the South Metropolitan Gas Company, where the purifiers are in the open on the ground level, the material is economically handled by being filled into small tip trucks (Fig. 67) drawn by diminutive locomotives. The spent material is taken away in this manner, and also the fresh material brought to the purifiers.

VALVES FOR PURIFIERS.

It has already been stated that the most usual plan is to arrange the purifiers in groups of four, the direction of the gas and sequence of purifiers in action being controlled by a centre valve.

The ordinary type of dry-faced valve for this purpose is circular, and consists of three main castings (Fig. 62). The centre one is divided into compartments, there being two concentric divisions in the centre, forming main inlet and outlet compartments; and radiating from the outer of these, a division forming a compartment for each of the inlets and outlets of the four purifiers. On the outside of this casting are provided sockets for connecting pipes, and these communicate with the interior compartments. The bottom casting forms a syphon into which a drain-pipe seals from each compartment of the valve. The top casting is a deep cover, having divisions in it forming five compartments. The first connects the main inlet with the first purifier, the next two connect the first, second, and third purifiers respectively in rotation, while the fourth connects the outlet of the third purifier with the main outlet of the valve. The fifth compartment forms a blank over the inlet and outlet of the fourth purifier, which is therefore shut off for refilling.

All the lower edges of the divisions in the cover, and upper edges in the centre casting are carefully scraped up to a true surface to make gas-tight joints. On the periphery of the cover is cast a toothed spur wheel into which gears a pinion wheel. On rotating the cover by this means one quarter turn to the right, the blank compartment comes over the inlet and outlet of No. 1 purifier, which is thus shut off, while No. 4 is brought into use as the last of the series.

In large sizes this valve is very difficult to make and to keep perfectly gas tight, and for this reason is not often used now in large works. It is sometimes replaced by a number of independent slide valves, but as twelve of these is the minimum that can be used for working four purifiers in rotation, they often give rise to confusion, and mistakes may occur when changing unless great care is exercised.

A centre valve, having much to recommend it, is one invented by Weck and made by C. & W. Walker, of Donnington (Fig. 64). It combines the advantages of a centre valve with the greater certainty from the use of slide valves. It is made rectangular in shape and horizontally is divided into a main inlet and outlet compartment. A disc valve—having faces on both upper and lower sides, and having outside screw for raising and lowering the discs—is used for inlet and outlet of each purifier. These when screwed up connect respectively to main inlet or outlet, and when screwed down connect by means of top hoods to inlet and outlet respectively of adjoining purifiers. It is therefore only necessary when working the valve to remember that the screw of inlet to first purifier and outlet of last must be up and all others down. Moreover, by this arrangement one, two, three or four purifiers can be in use at once. The disc valves are guided as they ascend and descend to prevent rotating, and their faces are made of lead.

There is, however, with all dry-faced valves of whatever description, some risk of foul gas passing through leakage of

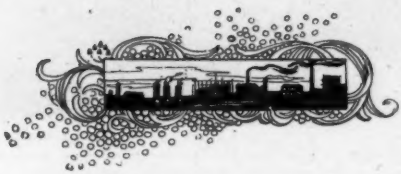
FIG. 66.—VIEW OF HEAD OF ELEVATORS ON THE UPPER FLOOR OF PURIFIER HOUSE AT THE NEEPSEND GASWORKS, SHEFFIELD.

FIG. 67.—NARROW-GAUGE TRUCKS AND LOCOMOTIVE USED FOR MOVING PURIFYING MATERIALS AT THE EAST GREENWICH GASWORKS.

valve faces, and the only absolutely certain valve is that formed by a water seal. Recognising this fact, Cutler and Sons, of Millwall, have designed and patented a very compact and complete arrangement of water valves for purifiers which gives absolute assurance against this leakage (Fig. 63).

(To be concluded in the next issue.)

Fletcher W. Stevenson



Pneumatic Tools and Appliances.

By EWART C. AMOS. M.I.Mech.E.

(Continued from page 301.)

RIVETERS AND DRILLS.

In the last article, attention was called to the advantages possessed by the percussion type of riveter for certain classes of work, owing to its lightness and portability. This feature is well illustrated in Fig. 38, which shows a "Q. and C." pipe yoke riveter, having a 9-ft. gap, and fitted with a pneumatic holder-on. Such a light frame as this would only be practically feasible in a percussion riveter, since a compression riveter of the same gap capacity would require to be much heavier. It is not, of course, intended to do such heavy work, but it will do a large amount of riveting that has hitherto been done by hand. The same type is made with various sizes of gap from 18 in. upwards, and to give an idea of its capacity it may be stated that a riveter having a 6-ft. gap, and weighing about 5 cwt., will close $1\frac{1}{4}$ in. rivets hot or $\frac{9}{16}$ in. rivets cold, and consume about 8 to 10 ft. of free air per minute.

Fig. 39 shows a "Ross" patent copper stay riveter with a gap of 6 ft. 3 in. This machine consists of a riveted plate steel yoke, at one end of which is a cradle carrying a large size "Ross" hammer. The cradle is fitted into a conical casing at a suitable angle for shaping the stay head. On the other arm of the yoke is an adjustable solid holder-on. The hammer having been set in motion by the admission of air and the cradle revolved, the work is satisfactorily carried out. It is stated that this machine will close copper stays at the rate of 80 to 100 per hour, and gives much better results than with hand labour.

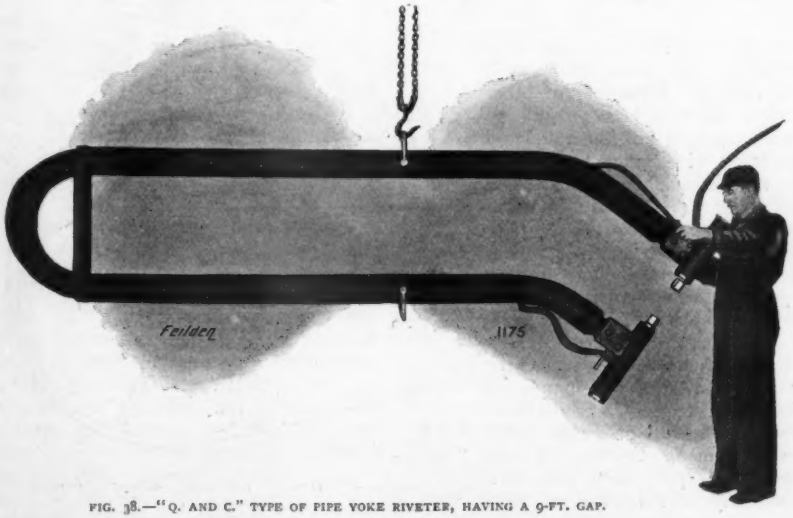


FIG. 38.—"Q. AND C." TYPE OF PIPE YOKE RIVETER, HAVING A 9-FT. GAP.

FIG. 39.—"ROSS" PATENT COPPER STAY RIVETER.

So far only the percussion type of riveter has been dealt with, and although a number of other designs of this class might be shown, those already illustrated and described will suffice to indicate the kind of machine at present on the market. In the author's opinion, the possibilities of their extended application for a variety of purposes is exceedingly promising, and in combination with compression riveters they appear likely to almost entirely supersede hand-riveting. In many cases neither the hydraulic nor the compression pneumatic riveter has been able to compete with hand-riveting, either on account of expense, or from absence of portability, and it is essentially in that class of work where hand-riveting has held the field that the percussion riveter will show itself to be a great labour-saving device. It is true that our engineers have not at present taken to it very largely, but in America it has had, and is having, a very extensive trial with satisfactory results. The advantages of hydraulic riveting are well known, and for stationary machines—and especially in boiler work—this system is likely to hold its own, since the question of piping for supply and the difficulty of disposing of water are not so appreciable as in the case of portable machines. The compression air-riveter is likely, however to seriously compete with it where porta bility is necessary, and especially for working in the open air, since it lends itself to doing equally good work within certain limits, and does not suffer from some of the disabilities found in its rival, as referred to above, since the exhaust air, of course, is capable of discharge into the atmosphere without any inconvenience. Such a type of machine is shown in Fig. 40, which illustrates a "Fielding" portable pneumatic compression riveter, in which the rivet is closed by a compression action

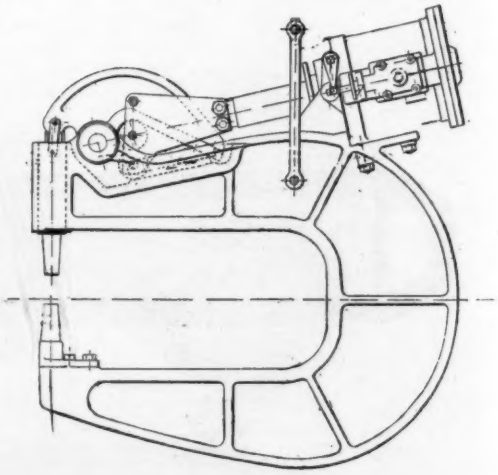


FIG. 40.—"FIELDING" PORTABLE PNEUMATIC RIVETER (COMPRESSION TYPE).

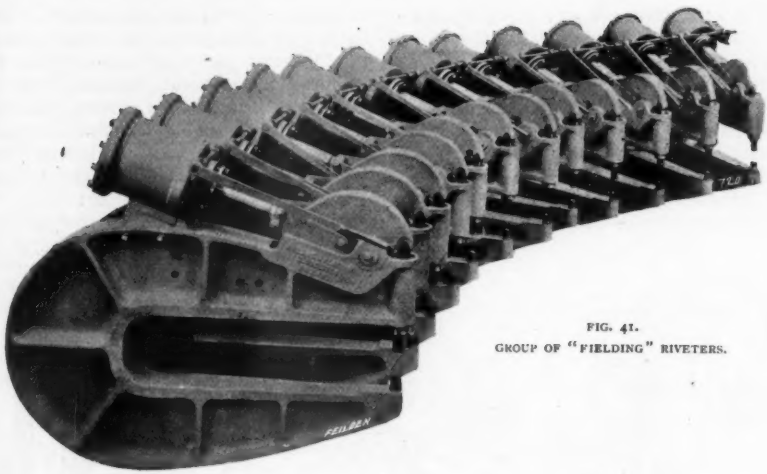


FIG. 41.
GROUP OF "FIELDING" RIVETERS.

as distinct from the percussive system already described. Fig. 41 shows a group of these machines. As is well known it is very desirable that no variation should occur on the closing pressure on the rivet, and that the riveter should be capable of automatically adjusting itself to any irregularity in the length of the rivet, thickness of the plate, or clearness in the rivet holes. Certain types of riveters of this class meet this difficulty by the use of adjusting screws which regulate the distance between the dies, but since such regulation is dependent upon the skill and attention of the operator, it lends an element of uncertainty to the production of satisfactory work. In the riveter illustrated a virtually constant pressure is exerted upon the rivet through the last quarter of the stroke of the riveting die, due to the special design of the lever arrangement through which the air cylinder works. By this means any variation affecting the finished length of the rivet produces no difference in the pressure exerted upon it, an advantage of considerable importance for securing good work, and which at the same time avoids the necessity of adjusting the dies. Another feature in this machine is that the compressed air employed on the working stroke is used expansively to cause the return stroke. The machine consists of a strong steel yoke carrying the usual dies or snaps, the bottom die being a fixture, whilst the top one is forced down by a lever which is actuated by rollers attached to the piston rod of the air cylinder, which is placed on the top of the yoke, the action being that of a roller working on an inclined plane. The air cylinder is controlled by a regulating valve actuated by the operator. These machines are made in stock sizes ranging from 2 ft. to 5 ft. gaps, and will close up to 1 in. rivets.

Another type of compression riveter to which attention must be called is the "Gaskey" Portable Riveter, illustrated by Fig. 42.

This system also effects a maximum pressure on the rivet, to secure which a main cylinder and an intensifier are used. The frame or yoke is a steel casting, upon which is mounted an air cylinder (1). Alongside of this is an oil cylinder (29) containing a floating piston (24). One side of this piston is in constant communication with the air supply, whilst on the other side of it is an oily fluid or some non-freezing mixture. This oil cylinder communicates with a hydraulic intensifying chamber (19) and a hydraulic chamber

(20), in which latter works the dolly bar (13); 12 is an actuating valve for controlling the air supply to the two cylinders (1 and 29) and to exhaust. No adjustment of the length of the dolly is needed when riveting on various thicknesses of material, since it is brought up to its work by direct air pressure before the hydraulic intensifier effects the actual riveting. The action is as follows : The first movement of the lever of the three-way operating valve (12) exhausts the air from in front of piston (4) of main cylinder (1), also from the underside of the dolly bar (13). This permits the fluid in the oil chamber (29) to be forced by the floating piston (23) into the hydraulic intensifying chamber (19), and through into the hydraulic chamber (20) over the top of the dolly bar (13), thus pressing the dolly bar and the die down on to the rivet, when the dolly ceases to move. A further movement of the valve (12) admits air to the main cylinder through the port (36), and causes the piston (4) to travel forward. At the same time the intensifier rod (18) enters the hydraulic intensifying chamber (19) and forces the dolly bar downwards, thus imparting the necessary pressure to form the rivet head.

After this operation is completed the dolly and dies are positively moved back from the rivet in readiness for driving the next one. It will be noted that this type of riveter utilises hydraulics besides compressed air ; the fluid used in the hydraulic portion, however, is used over and over again, and does not require a constant supply as in an ordinary hydraulic riveter. This principle has been applied to a number of different designs for various classes of riveted work. Fig. 43 illus-

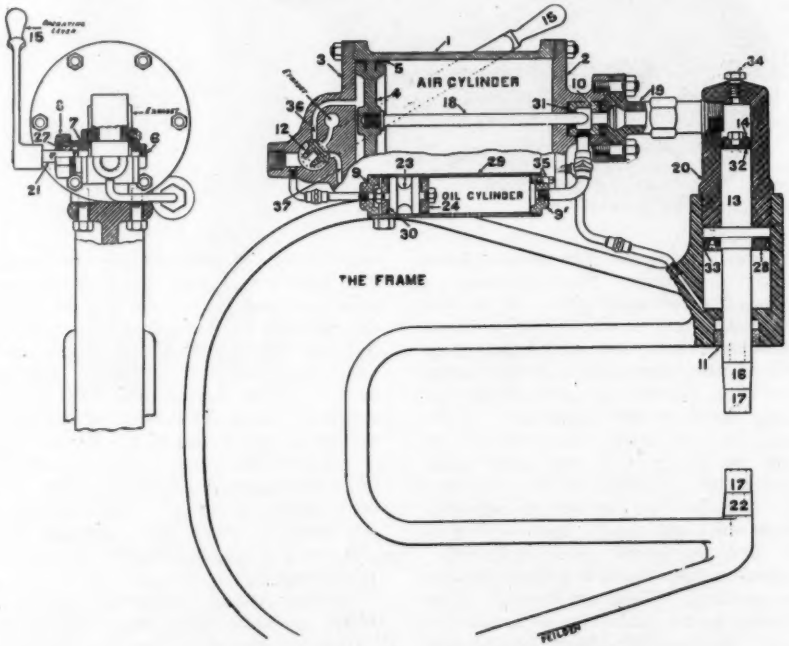


FIG. 42.—"GASKEY" PORTABLE PNEUMATIC RIVETER.

trates a "Gaskey" Portable Lattice or Column Riveter as applied to boiler work. This machine is adapted to rivet lattice struts and columns, and is of such shape that it can be inserted in columns or struts as small as 4 in. deep. The machine illustrated has a 10 in. gap; the spread of gap being 10 in., and stroke of die $4\frac{1}{2}$ in. It will close rivets up to 1 in. diameter, and will work economically with air at 80 lb. pressure. Before leaving this part of the subject, it may be interesting to compare the relative speeds and costs as between hand and pneumatic caulking and riveting. Taking first an American test as carried out at the Chicago Shipyards at the latter end of last year, it was found that the average cost of machine riveting (the rivets varying in size from $\frac{3}{4}$ in. to 1 in., and driven in various parts of the ship) was 1.5 cents per rivet, whilst by hand it was 3.19 cents per rivet, the saving effected being, therefore, 1.69 cents. per rivet, and the average cost of machine riveting being only 47 per cent. of hand riveting. Again, 70 $\frac{7}{8}$ in. rivets can be driven per hour per riveter, whilst 60 fire box stays (or 120 heads) can be driven in the same time.

With regard to caulking, it may be taken generally that a man with a pneumatic caulking tool can do the work of from three to six skilled caulkers, whilst an eminent locomotive superintendent has stated that he has found a saving in cost of 60 per cent. over hand caulking, and with a result equal to the hand work. At the same time the plates are punished less, which makes pneumatic caulking especially suited for light plates, such as tenders and tanks; also for cutting off thin plates pneumatic tools have proved very satisfactory, and the work can be done in about a quarter of the time for punching and shearing. The writer has seen a chipping 7 in. long and $\frac{5}{8}$ in. thick, cut from a $\frac{1}{2}$ in. boiler plate in 58 secs. Referring again to cost; a boiler shell 20 ft. long by 6 ft. in diameter can be caulked for about 6*s*. to 7*s*., and it is also stated that one man can caulk a locomotive shell in about 5 hours. In shipwork, one man can caulk one yard per minute. Many other examples might be given, but these will suffice to indicate the great saving effected by the use of pneumatic tools of the class described. Other examples will be given of drilling when dealing with that part of the subject.

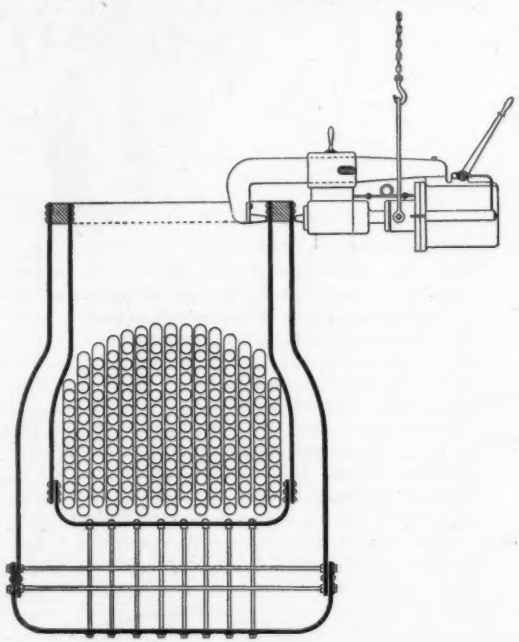


FIG. 43.—"GASKEV" PORTABLE LATTICE OR COLUMN RIVETER, AS APPLIED TO BOILER WORKS.

PORTABLE PNEUMATIC DRILLS.

Some objection has been raised in this country against the use of pneumatic hammers and riveters, due to the vibration which is found in all of them. There is some ground for objection, but as is well known, there are a large number of mechanical appliances against which some

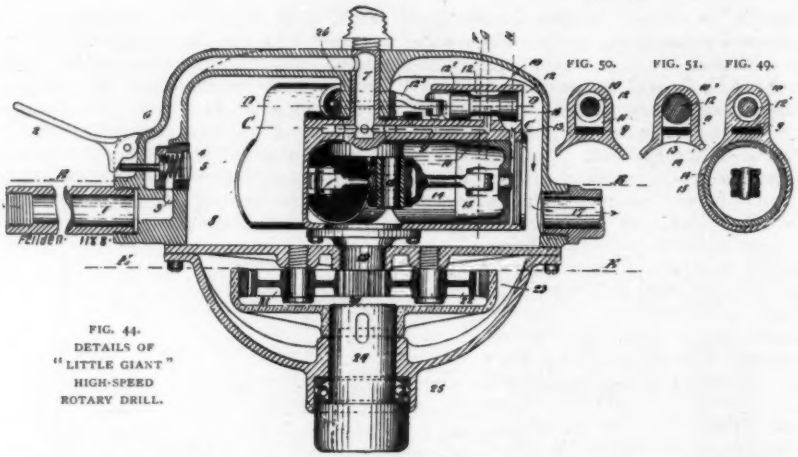


FIG. 44.
DETAILS OF
"LITTLE GIANT"
HIGH-SPEED
ROTARY DRILL.

form of objection or other exists, and yet same are in constant use, since their advantages outweigh their disadvantages. It will be found that practice will enable the operator to very greatly minimise the effect upon himself of the percussion action of the tool, although the initiated will suffer considerable inconvenience. Whether the complaints already referred to in regard to hammers have any serious grounds or not, they have no existence when compressed air is utilised for the purpose of driving rotary motors or drills, and in the writer's opinion, the portable pneumatic drill, with its many applications, is one of the most important additions to our plant of labour-saving machines. In connection with shipbuilding and constructional ironwork alone it has a big field, as a great deal of work which, for economic reasons, has had to be drilled in the shop previous to erection can now be drilled in place, and the cost is thereby greatly reduced, besides giving much better results.

Besides drilling, portable pneumatic drills will be found to effect great economy when used for reaming, tapping, tube expanding, cleaning castings, boring wood, screwing nuts on bolts, boring cylinders

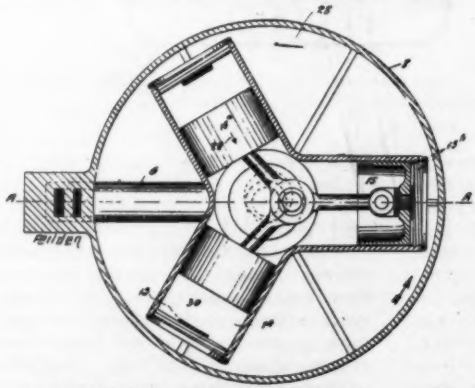


FIG. 45.—SECTIONAL PLAN ON LINE B–B, FIG. 44.

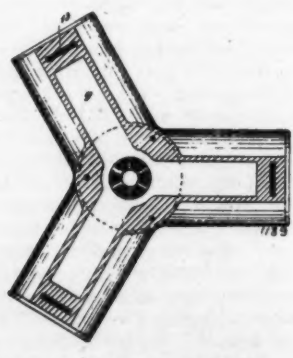


FIG. 46.—SECTIONAL PLAN ON LINE C–C, FIG. 44.

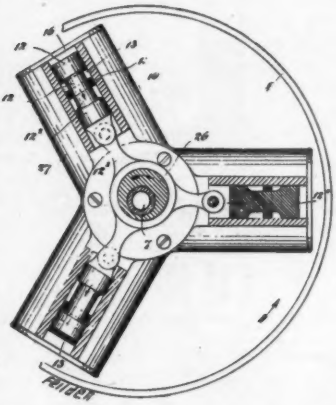


FIG. 47.—SECTIONAL PLAN ON LINE D–D, FIG. 41.

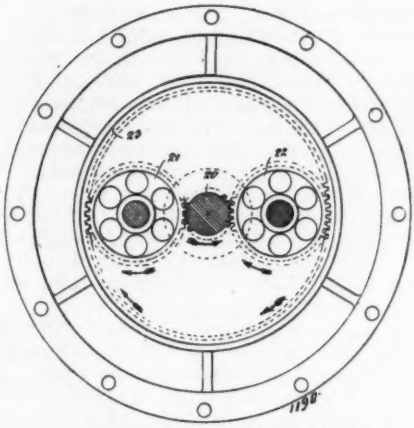


FIG. 48.—PLAN SHOWING REDUCING GEAR.

and Corliss valve seats, grinding steam pipe joints, turning up crank and car wheel pins in position, and a variety of other purposes which will readily suggest themselves. The method by which compressed air is utilised for driving the drills, is usually by means of single or double-acting cylinder motors, the cylinders of which are either fixed or oscillating, and these again actuate suitable mechanism for driving the drill bit, all being usually fitted in a casing to keep the working parts free from dirt, the casing also, sometimes acting as a reservoir.

The air pressure employed is usually 60 to 80 lb. to the square inch.

Coming now to a description of some of the machines at present on the market,

DESCRIPTION OF THE "LITTLE GIANT" HIGH-SPEED ROTARY PNEUMATIC DRILL.

Figs. 44 to 51 illustrate the "Little Giant" high-speed rotary drill, which consists of a casing containing three rotating cylinders, each of which is governed by a piston slide-valve, which valves rotate with, and work in, cylinders or valve chambers forming part of the main engine cylinders. In other machines for effecting the same and similar purposes the casing is used as a live air chamber; in the "Little Giant" type it is used as an exhaust receiver. Again, in other machines the air has been directly admitted into the casing or live air chamber, whereas with the "Little Giant" drill it is carried through a separate channel from the supply pipe and through a stationary or fixed crank shaft into a passage leading to the reduced portions of the piston slide-valves and, according to the position of such valves, admitted to, or exhausted from, the cylinders. It will also be noticed that in the "Little Giant" drill the exhaust does not blow through the gear mechanism, since it is so arranged that it is admitted into the main casing, which itself is hermetically sealed from the lower portion of the machine which contains the reducing gear, so that the exhaust passes out through a separate pipe as shown in the diagram.

The leading feature in the "Little Giant" machine is that it combines a high-speed engine with a low consumption of air, and this result has been obtained by employing a stationary eccentric, which is set at the required point in the throw of the crank-shaft to obtain the necessary cut off, the cylinders and their governing slide-valves rotating about this eccentric. As is well known, in engines of this type the travel of the eccentric should be quickest when the motion of the piston is slowest, and this is provided for in the present design by having a very quick port opening and an equally quick re-

lease, thus enabling the rotating cylinders to move at an exceedingly rapid rate, the air not having to travel through tortuous passages either in or out. With other engines of this character, especially with engines of the oscillating type, where the valve motion is slowest when the piston is in the centre or at the end of its stroke, this condition does not exist.

Referring to the diagram,

Fig. 44 is a vertical section of the drill on line *A-A*, Fig. 45.

Fig. 45 is a sectional plan on line *B-B*, Fig. 44.

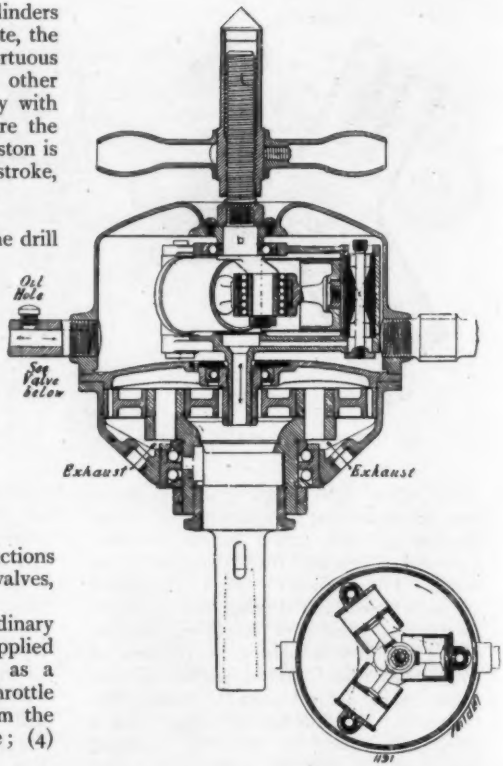
Fig. 46 is a sectional plan on line *C-C*, Fig. 44.

Fig. 47 is a sectional plan on line *D-D*, Fig. 44.

Fig. 48 is a plan of a portion of the machine with the casing removed, showing the reducing gear. This is a section slightly above the line *E-E*, Fig. 44.

Figs. 49, 50 and 51 are cross sections through the governing slide valves, on lines *F*, *G*, *H*, Fig. 44.

(1) is the supply pipe, of any ordinary type, by which the machine is supplied with air, and which also serves as a handle; (2) is the trigger of the throttle valve; (3) the passage leading from the supply pipe (1) to the throttle valve; (4) the throttle valve; (5) its retaining spring; and (6) the supply passage leading to the hollow crank shaft (7); (8) is the casing or main chamber in which the cylinders and their governing valves rotate. As part of the casing (8) and depending therefrom is an eccentric (26), into which eccentric is permanently fixed the crank shaft (7), and it is by means of this eccentric that the slide valves derive their lateral motion and the cylinders are thereby caused to rotate. There is provided above each of the rotating cylinders a passage marked (9), and



FIGS. 52 AND 53.—TRANSVERSE VERTICAL AND HORIZONTAL SECTION OF A "BOVER" PISTON DRILL.

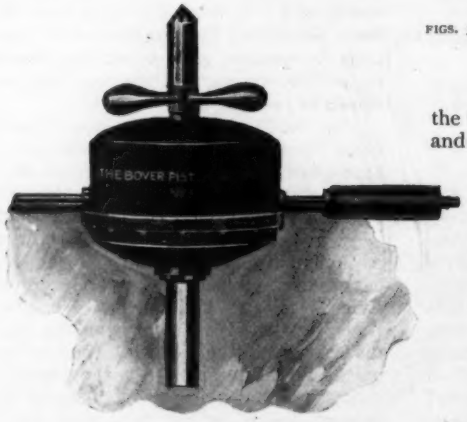


FIG. 54.—"BOVER" PISTON AIR-DRILL.

above these passages are three valve cylinders or bushings (10) in which three valves (12) reciprocate, and control the admission of air to the cylinders. (12^1) is the neck or reduced portion of the reciprocating valves, between the enlargements (12) and (12^2); (12^3) is the connecting rod between the valve and the eccentric (26) and surrounding same. The neck (12^1) permits of the admission of air through the port (11) to enable it to get through passage (13) into the cylinder (14) when the valve is moved through its rotation with the cylinders about the fixed eccentric (26); (15) are the pistons in the main rotary cylinders; (16) is the open end of the valve cylinder (10) by which the exhaust air travels into the main chamber or casing (8) and out through the exhaust passage (17). One of the main advantages derived from utilising the main chamber (8) as the exhaust chamber is that the air has a large area to be received in and it is immediately released through passage (17) without having to pass through any tortuous passages, thereby obviating all possibility of freezing during winter; (18) is the crank pin, to which the connecting rods of the pistons are connected as shown; (19) is a pin or fulcrum fixed to the cylinders (14), and upon this pin a pinion (20) is keyed; working in connection with the pinion (20) are two idlers or transmission wheels (21) (22), and these transmission wheels work in corresponding teeth of the internal gear (23) which is keyed to the spindle (24), into which spindle the tool to be rotated is inserted. A ball bearing (25) is provided to take up end-thrust on the tool. The ordinary feed mechanism (not shown) is fixed at the top of the machine.

The working is as follows: with the trigger (2) of the throttle-valve in the position shown the machine is inoperative, the throttle-valve being closed against the admission of air. By depressing the trigger (2) air is admitted from the supply pipe (1), through 3, into the passage (6) and through hollow crank shaft (7) along passage (9), through port opening (11) into the valve cylinder (10), around the neck (12^1) of valve (12). The valve in Fig. 44 shows the connection as closed between ports 11 and 13, but if reference is made to Fig. 47 [where, for the sake of clearness, the cylinder is shown by a separate number (27)], it will be seen that the air is coming from passage (9), through the port (11), and passing down through port 13 into the rear of piston (15^A). Fig. 45 forces the same in the direction of the arrow (29) and causes thereby the cylinders to rotate in the direction of the arrow (28), or to the left. This action of rotating round the fixed eccentric (26) would cause the valve (12^4) (Fig. 47) to be moved away from the centre of rotation or outwards towards the case, which would admit air behind the piston (15^B) (Fig. 45); air would be at the same time exhausting from the rear (30) of the cylinder (14) (Fig. 46), such exhaust air passing from the space (30) through the same port (13) behind the valve (12), out through the open end (16) and away through the passage (17) shown in Fig. 44. On reference to Fig. 47, it will be seen that the valve (12) uncovers port (13), allowing the exhaust air to come through the open end of the valve cylinder into the case (8), and out through the opening (17). The passage (9) above referred to acts as an air receiver common to the three cylinders. As the machine rotates the same cycle of operations continues.

Fig. 52 illustrates a transverse vertical section of a "Boyer" piston drill, and Fig. 53 is a horizontal section taken through the centre of the cylinders. Fig. 54 shows an outside view of same. The machine consists of three main parts; (1) the upper housing into which the throttle valve and steadying handle are screwed, and which forms a live air chamber carrying the motor; (2) the diaphragm which forms the lid or cover of the upper housing or live air chamber, and through which the hollow exhaust spindle projects; (3) the lower housing secured to the upper housing by means of screws, and containing the gear-wheel rack, bearings for drill spindle, etc. The motor is in the form of a three cylinder single-acting oscillating engine, the cylinders being carried in a rotary frame. This frame consists of an upper and lower plate, and is triangular in shape, as shown in Fig. 53,

FIG. 55.—"LITTLE GIANT" REVERSIBLE FLUE ROLLING MACHINE AND PISTON AIR-DRILL IN OPERATION.

and is free to revolve round its centre on two bearings, the lower one being a hollow shaft, and connected by gearing to an internally toothed wheel in the lower half of the casing. The admission of air to the cylinders is regulated by the valves formed in the pivots upon which the cylinders vibrate. The cylinders are single-acting, and the inner ends are open, and therefore air under pressure, of which the upper casing is always full, has free access to the pistons on that side. It would seem, therefore, that air being admitted through the pivot valves would only produce equilibrium, but since one of the cylinders is always open to the exhaust through the hollow bearing of the triangular frame, this equilibrium becomes disturbed, and the compressed air has full effect upon each piston as its valve comes in line with the exhaust. The cylinders are constructed of steel tubes and are fitted with trunk pistons having their connecting-rod ends attached to a fixed crank-pin common to them all. The pistons having been set in motion by the introduction of compressed air into the upper casing, and into the cylinder as already described, has the effect of causing the three cylinders, together with their triangular framing, to rotate round the fixed crank-pin, and thus transmit rotary motion to the spindle by means of the gearing before referred to.

Fig. 55 shows a "Little Giant" reversible flue rolling machine, and a piston air-drill in operation. These machines will be described and illustrated in the next article, together with several other types of drills.

(*To be continued.*)

Ewart S. Amos

The Building of a Great Railway.

The Great Central Extension to London.

(Continued from page 314.)

THE METROPOLITAN DIVISION.

THE London Metropolitan Division of the Great Central Railway really commences near Canfield Gardens, in South Hampstead, to which point the trains of the Great Central Railway run from Quainton Road over the rails of the Metropolitan Railway, the last 5 or 6 miles being a widening of the original line of the Metropolitan Railway, specially constructed for the Great Central Railway, and over which no other Company may be authorised to run, by the Metropolitan Railway Company.

But before reaching Canfield Gardens, the traveller from the north will have noticed, between Wembley Park and Neasden, on his right hand side, a large yard containing several miles of sidings, and many large buildings. These are the sorting sidings and shops of the Great Central Railway, and here the work of dividing up the various classes of goods traffic, to and from London, and of sorting the coal wagons for the various owners and consignees, is carried out. The shops consist of a large locomotive shed, capable of housing 30 large locomotives; a carriage and wagon repairing shop, 350 ft. in length by 120 ft. in width; electric lighting works, besides tank house, sand drying shed, offices, stables, and many other necessary buildings for the various purposes of the Company. There have also been built for the use of the employés of the Company 150 convenient cottages, suitable for the various classes of men, who either work in the shops or yards or who man the trains starting northwards from the metropolis.

In constructing these works and buildings, which extend over a distance of a mile alongside the railway, and in some parts lie a quarter of a mile distant from it, a very large amount of earth-work has been deposited in order to raise the level of the ground to the requisite height, and all the surplus earth from the London tunnels, covered ways, and other excavations, has had to be conveyed by trains, running to the number of 18 a day, for nearly three years, over the Metropolitan Railway.

Across this land runs the River Brent;

MR. STENNETT,
Agent for Mr. J. Firbank, M.P., Contractor of the Metropolitan Division.

and in laying down the large group of sidings it has been necessary to construct a covered way, consisting of two spans of 20 ft. each for a length of 500 ft., through which the river runs as in a brick tunnel. The Brent feeder too, which carries the accumulated water of the river from the well-known Brent Reservoir, at the Welsh Harp, on the Edgware Road, to supply the Grand Junction and the Regent's Canal, passes under the sidings for a length of 1,100 ft., by a

MAP OF THE METROPOLITAN DIVISION, CONTRACT NO. 7.

MR. E. WRAGGE, M.I.C.E.,
Resident Engineer of the Metropolitan Division.

conduit 10 ft. in width, and a further length of the same feeder has had to be enclosed within walls, ready for arching over at a future time, when rendered necessary, for a further distance of 660 ft.

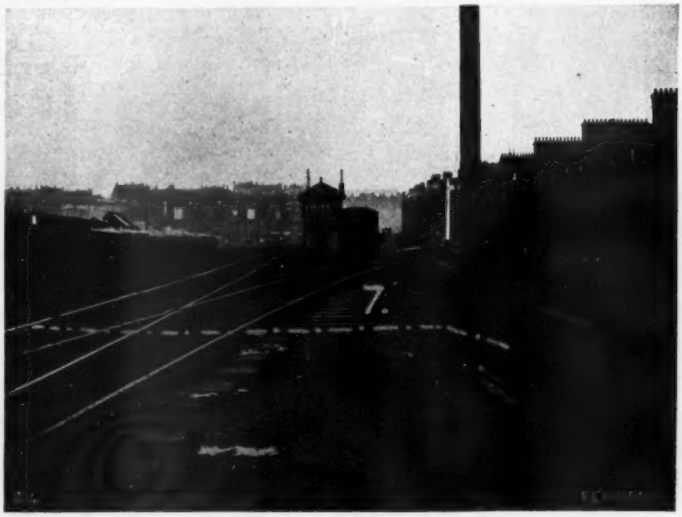
Two new sewers, 4 ft. 6 in. × 2 ft. 6 in. required by the Willesden District Council,

aggregating a mile in length, have also been carried through the grounds, and a bridge of four spans, to carry Dog Lane over the railway, and a new roadway 40 ft. in width have also been constructed.

To revert, however, to the construction in London. The lines of the Metropolitan widening terminate at an agreed point some 200 ft. north of Canfield Gardens, where they are met by the lines owned by the Great Central, there being no junction in the ordinary acceptation of the term, but the rails of one Company cease, and those of the other Company commence.

At the north side of CanfieldGardens the line of the Great Central immediately disappears underground from which point a continuous covered way has been constructed, with two lines of rails, as far as Hillgrove Road, a distance of 692 yards, where it emerges into the open again, though only for a length of 125 yards, during which it crosses over the main and local lines of the London and North-Western Railway just west of the west end of the Primrose Hill tunnel, and close to the Loudoun Road station of that railway.

At the north side of Alexandra Road the line again passes into covered way, in which it continues until a few yards south of Carlton Hill, having in this length passed from Hampstead into Marylebone parish near Boundary Road. At the end of the covered way above mentioned, the surface of the ground rises rapidly, and a change in the method of construction has here been made from covered way to tunnel, a transition, however, not noticeable to the traveller. The tunnelled portion extends for a length southwards of about 700 yards to a short distance south of Circus Road, at which point covered way was again adopted as the method of construction, and continued to a point 240 ft. north of Wellington Place. At this point there is a large opening



END OF CONTRACT NO. 7. JUNCTION WITH METROPOLITAN RAILWAY (MIDWAY BETWEEN WEST HAMPSTEAD AND FINCHLEY ROAD STATIONS, LOOKING EAST).

240 ft. in length by a width sufficient for seven lines of rails, which have been laid south from the end of the covered way, through which, and through the tunnel, and across the bridge over the London and North-Western Railway only two lines of rails have as yet been laid, although the Company has in most places already secured sufficient width of land for two more lines, should the development of the traffic render the additional accommodation necessary, which we hope may not be long deferred.

At Wellington Place the line passes under Lord's Cricket Ground—that is to say, it passes under a portion of what was, before its construction, a corner of Lord's Cricket Ground, and under the grounds formerly belonging to the institution known as the Clergy Orphans' Asylum. By arrangement, however, with the Marylebone Cricket Club, not only has the small portion of Lord's passed under been restored to the ground, but the additional area of the Clergy Orphans' Grounds—amounting to about $1\frac{3}{4}$ acres—has been added to the Cricket Ground, which is now in consequence provided with a second ground upon which matches can be played. Fears were entertained by many, when this line was first proposed to pass under Lord's that the famous ground would be irreparably spoilt, but we believe we are breaking no confidence in stating that the Committee and the members of the Club are exceedingly well satisfied with the result which has been accomplished, and as the construction of the line only occupied from September, 1896, until May, 1897, no cricketing season was lost. The railway construction under Lord's has been made wide enough for seven lines of way; these are accommodated in three archways, the easterly one adjoining the Wellington Road, having a span of 40 ft., and covering three lines of rails, and the two next, each for two lines of rails, having spans of 26 ft. 3 in.

There are about 6 ft. to 8 ft. of clay from the top of the arches to the soil which was laid under the sodding, and a few drain-pipes were carried down to the lines below, so that the turf should not be sodden at any time by wet, and the Engineers believe that they are not sufficiently plentiful to remove too much of the moisture required to keep the turf in good order.

ENTERING LONDON. RETAINING WALL BETWEEN CANFIELD PLACE AND BROADHURST GARDENS.

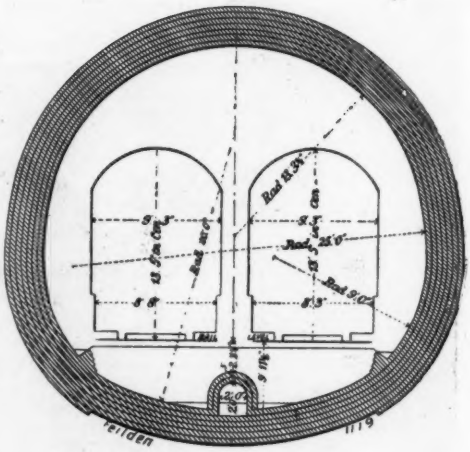
Immediately after passing under the cricket ground the railway passes under St. John's Wood Road, with openings of similar spans to those mentioned above, the total length from Wellington Place to the south side of St. John's Wood Road bridge being 709 ft.

At this point the line emerges into the open, being a distance of 2,481 yards from the point of connection with the Metropolitan at Canfield Gardens, and from here to the various termini of passengers, goods, and coal, it remains in the open.

Before, however, proceeding to speak of the works southwards, from this point, we will endeavour to mention some of the Engineering features of the work over the ground which we have already covered.

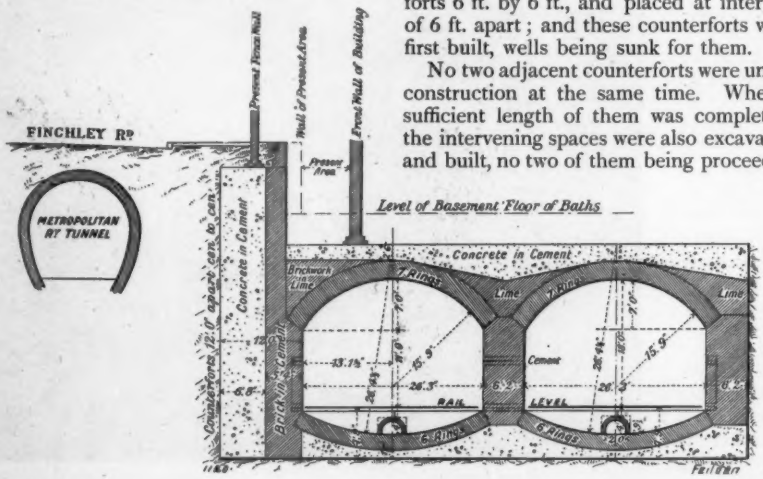
And first as to the Covered Way. This was in most instances constructed in lengths of 12 feet, the whole width of the excavation from the back of one wall to the back of the other, representing about 39 feet, being taken out at once and well strutted across the opening with large timbers.

Before, however, this was commenced a heading 12 ft. square was driven through the whole length from Canfield Gardens to St. John's Wood Road, as under the stringent conditions of the Act of Parliament, authorising the railway, no earthwork or other materials might be carted through the streets, and all the excavation as already mentioned was consequently run over the Metropolitan Railway to Neasden, while all bricks, gravel, cement, timber, and other materials necessary for the work, were also carried over the same railway, thus affording to that Company a considerable addition to its revenue. The walls and arch of the covered way were constructed throughout of brickwork, faced in both cases with Staffordshire brindle bricks, and the invert was formed of concrete in cement. In some places the new line runs in close proximity to the Metropolitan Railway near the Finchley Road and Wellington Road, although at a lower level; and, in order to make sure of the proper protection of the Metropolitan, the walls adjacent to it were constructed in a somewhat different manner. They were strengthened by means of counterforts 6 ft. by 6 ft., and placed at intervals of 6 ft. apart; and these counterforts were first built, wells being sunk for them.



SECTION OF TUNNEL WORK, METROPOLITAN DIVISION.

No two adjacent counterforts were under construction at the same time. When a sufficient length of them was completed, the intervening spaces were also excavated and built, no two of them being proceeded



CROSS SECTION OF PORTION OF TUNNEL ADJOINING THE METROPOLITAN RAILWAY, SHOWING COUNTERFORT.

THE FIRST TUNNEL, UNDER CANFIELD GARDENS.

with at the same time. This strong retaining wall having thus been completed, the usual 12 ft. lengths were taken out as already described, except that the width of the excavation in such cases only extended from the face of the already built wall to the rear of the other one, representing a width of about 32 ft. This same method of counterforts was also adopted in a few other cases, where the safety of adjacent houses rendered some such course necessary. The results were most satisfactory in every case.

The tunnel was constructed from nine break-ups from the heading, and 12 feet lengths were also constructed in this case; the average time taken from the commencement of the excavation of each length to the keying-in of the arch, which consisted of seven rings of brick work, was 21 days.

In the tunnel, work was continued by day and night, ceasing only for Sundays. The excavation for the tunnel was through the London clay. Upon an average the upper half consisted of brown clay, and the lower half of blue clay, the latter, of course, being the more

CUT AND COVER WORKINGS NEAR HILLGROVE ROAD.

homogeneous of the two. In order to prevent settlement as much as possible, all the poling boards of the upper portion were left in, and also six poling bars in one length of bar, and five in the adjoining, they being allowed to overlap one another about 5 ft. These poling bars were all of large size, chiefly of larch, and from 18 in. to 15 in. in diameter. The spaces between them were built up as tightly as possible with brickwork.

Place the retaining walls are from 37 ft. to 32 ft. high above rail level, and were constructed with counterforts and in the same manner as previously described. It was considered advisable as a precautionary measure, owing to the treacherous and unreliable character of the clay at this part of the line, to construct in front of these walls and under the first line of rails a strong toe of concrete in cement about 14 ft. in width and extending to a depth of 12 ft.

OVER THE L. AND N.W. RAILWAY MAIN LINE, LOUDOUN ROAD, LOOKING SOUTH, SHOWING NORTH END OF SECOND TUNNEL.

At as many convenient places as possible openings for ventilation were left both in the covered way and the tunnel, and as far as possible they were made of the full width of the covered way and the tunnel, 26 ft. 3 in. by 20 ft. in length; where they occurred in the tunnel, they were constructed as lengths of covered way, and excavated from the surface.

At the large opening at Wellington below rail level, and this was put in in lengths of 12 ft. after the rest of the wall had been completed.

In constructing the triple covered way under Lord's Cricket Ground, the walls were put in in trenches, the arches following afterwards, the surface of the ground having been first removed down to the level of the springing of the arches. As fast as the walls were built the arches

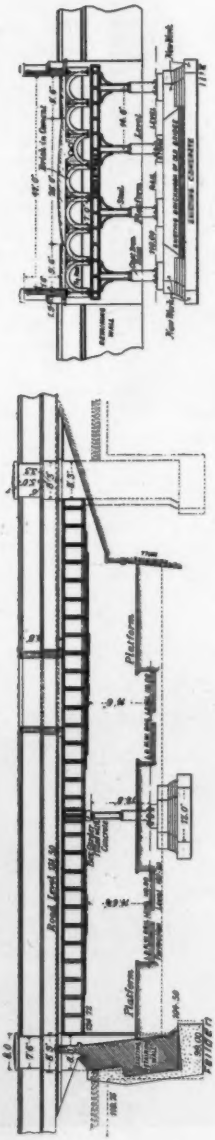
were followed on with, and holes in them being left here and there, the dumpling was removed from below, and by means of steam cranes, was lifted through them and filled again on the top of the arches, dry rubble drains having first been built up in the spandrels. A large quantity of original top soil was laid aside in commencing this work, and this, with other soil brought to the spot by train, was spread over the clay to a depth of 18 in., and the whole was sodded with sods obtained from Morley's Cricket Ground at Neasden, which had to be destroyed in the construction of the sidings and other work at that place.

The bridge under St. John's Wood Road involved a considerable amount of work. There were several large water-mains which crossed the bridge at various angles, and all of these had to be diverted to straight lines parallel to one another, and to be placed between steel girders specially arranged to carry them. The new mains which took the place of the former ones were made of steel; three of them were 36 in. in diameter, while others were smaller, and large gas-mains had also to be provided for. At this road, as well as at nearly every road under which the railway passed, the sewer had also to be diverted; and at this bridge it was passed under the rails and the contents discharged into the King's Scholars' Pond sewer, which was fortunately of sufficient depth to admit of this being done. Other difficulties to be overcome at this place consisted of keeping open the entrance road to the St. John's Wood Road station of the Metropolitan Railway, while the abutment of the bridge was being built; of rebuilding the side entrance into the large sewer above referred to; and of constructing an arch diagonally under one of the abutments of the bridge, in order to admit of the sewer passing under it, and of making it of a size sufficient to permit the sewer to be enlarged in the future.

Between St. John's Wood Road and the Regent's Canal a large amount of excavation had to be made, necessitating a heavy retaining wall on the west side, upon which has since been built one of the walls of a large block of stables constructed for Messrs. Thompson, McKay & Co., the cartage agents of the Great Central, who have at this place accommodation for 650 horses. A bridge of 100 ft. span carries the Lodge Road over the railway a short distance south of St. John's Wood Rd., and from this point the line spreads out like the four fingers and thumb of the left hand when laid palm down.

SUPPORTS. BRIDGE OVER L. AND N.W. RAILWAY, LOUDOUN ROAD.

These



DETAILS OF BRIDGE OVER THE L. AND N.W. RAILWAY AT LOUDOUN ROAD.

lines extend across the Regent's Canal by a bridge of an aggregate length of spans of 80 ft., covering a length of nearly 300 ft. of the canal.

The line represented by the thumb of the hand turns sharply to the west and runs alongside the canal on its south bank, where there are four lines of rails under a large transfer-shed for interchange of traffic between the railway and the canal. This shed has a length of 500 ft., and the canal has been widened by 60 ft. additional, in order to form a basin, alongside of which the wharf covered by the transfer-shed has been constructed.

The coal railway comes next in order, being represented by the first finger. This consists of two lines of rails, which drop down from the level of the rails over the canal until they pass under Grove Road into a coal yard which has been laid out extending from Grove Road to Carlisle Street, a distance of about 900 ft. and having a width of about 240 ft. This yard has accommodation for some 230 wagons, and is also capable of storing a fair quantity of coal, as well as giving ample room for unloading and carting purposes. Adjoining the coal yard on Grove Road are offices for the use of the coal merchants; and here as well as on Samford Street (the southerly boundary of the yard) stabling available for 112 horses has been built. The level of the rails and roads has been arranged as far as possible to suit the level of Carlisle Street, in which the entrance to the yard is placed; and at this end, therefore, there is only a difference in level between the street and the rails of 4 ft. 6 in., so that an easy ascent from the yard to the street, with a gradient of 1 in 40, has been obtained.

The land upon which the coal yard has been built was previously occupied by a dense population inhabiting a very low class of house; and before the houses were removed the company had to erect artisans' dwellings, known as "Wharncliffe Gardens," in order to house the people who were thus dispossessed. These handsome buildings have been built with a frontage to Grove Road and St. John's Wood Road, and to the Regent's Canal.

SOUTH END OF SECOND TUNNEL, WELLINGTON ROAD.

Following out the simile of the hand, the second finger is represented by the lines of rails running into the goods yard; and, working southward and eastward from the coal railway, they are arranged as follows:

First come the lines which lead to the generating station, where hydraulic and electric power and electric light are generated for the general use of the yard and warehouses, etc. Here there are boilers aggregating 2,000 h.-p., which provide steam for the hydraulic pumps, of which there are two, and for the engines and dynamos, of which there are eight. The water for the use of hydraulic power is procured from the canal, and is pumped from it to the hydraulic building through 15-in. cast-iron pipes. After circulating through the various pressure pipes, the return water eventually goes back to the canal through outdraught pipes of similar size to the indraught pipes, and as there are meters on both indraught and outdraught, the difference between the quantities registered by the two represents the amount of water used, which, it may be remarked in passing, is required for several other purposes in addition to filling the mains.

THE THREE TUNNELS UNDER LORD'S CRICKET GROUND, LOOKING SOUTH.

The hydraulic power provided is used for the following purposes:—The working of six cranes and the various capstans in the transfer shed, as well as for the 25-ton hydraulic Goliath on the canal bank:—The working of 24 platform cranes, 9 upper floor cranes, 2 wagon hoists, and 12 outside hoists in the goods warehouse, and for the following other purposes in the goods warehouse:—six goods wagon traversers, the whole of the capstans on the ground floor, and in the basement, and outside the building, for the goods lift, for hydraulic injectors to fill the tanks in the water towers; for working the lift in the goods office, and for working three lifts in the passenger station. The outside goods yards come next in rotation to the generating station. These yards are all lighted by electric lamps (as are also the coal yard and the passenger yard) and a 25-ton Goliath, worked by electric power is also provided. Then follows the large goods warehouse with its wide covered wings on the east, west, and south sides.

SOUTH END OF THIRD TUNNEL (UNDER LORD'S CRICKET GROUND). ST. JOHN'S WOOD ROAD.

The goods warehouse proper consists of a basement, ground floor, and three upper floors. It is 384 feet in length from north to south, and 255 ft. in width from east to west. On the west side is the empties shed, and the roofing on that side extends to a width of 100 ft. outside the goods warehouse. On the east side the roofing has a width of 150 ft., and on the south the roof varies from about 30 ft. on the east side to 150 ft. on the west; the whole area roofed over being 5½ acres, and the whole floor area under roofing, including the vaults under a portion of the southern roof, being 15 acres.

There are three roadways through the building on the ground floor, a wide one through the centre, and a somewhat narrower one on each side adjoining the east and west walls of the building. Next to these roadways are platforms 27 ft. in width, four in all, and two sets of three lines of railway, six lines in all. In the basement there are four lines of rails, two near the centre and one under each side roadway, connected with one another by cross-lines by means of turn-tables. The wagons are lowered into the basement by means of hydraulic wagon hoists, placed respectively one at the north-east and one at the north-west end of the shed; and the whole of the basement, which is approached by an inclined roadway at the south end, having a gradient of 1 in 30, is paved to rail level with granite sets, and can therefore be traversed at any point by goods lorries and horses.

The structure of the warehouse consists of the four outer walls of heavy brickwork,

with built-up steel stanchions carrying strong steel plate girders. The ground floor, except under the platforms, is covered with Hobson's patent flooring, capable of carrying 5 cwt. per square foot. Nearly 7,000 tons of steel altogether have been used in this large building. The goods offices are situated at the angle of Grove Road and Rossmore Road, and have a considerable frontage upon both. The entrance gates to the goods yard passes under the first floor of the office, at the angle between the two roads; and, in addition to the lines leading to the carriage sheds, the milk platform, &c.

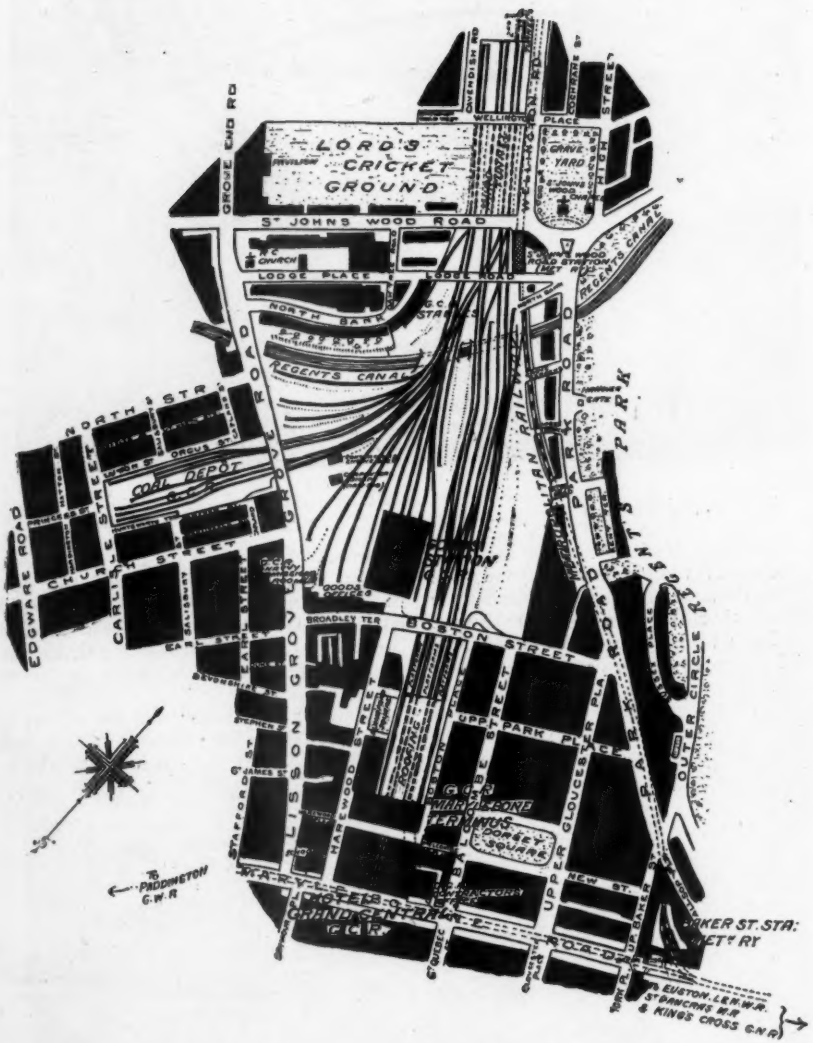
Upon leaving the canal bridge, the passenger lines drop by a gradient of 1 in 100 in order to pass under the bridge carrying the new street called Rossmore Road, which had to be constructed and put into use by the Company, from Park Road on the east to Grove Road on the west, before Alpha Road and other streets now closed could be taken possession of by the company for the construction of their works, and as this bridge and new

SIGNAL GANTRY ERECTED AT MARYLEBONE BY MESSRS. HOMAN AND RODGERS.

necessary offices for carrying on the work, the building contains large mess-rooms for the accommodation of the clerks employed in the building, and also for the checkers and porters in the warehouse. The building is heated throughout by hot water, and is lighted with electricity. All the floors are fitted with the "Grinnell Patent Sprinkler," as a protection against fire.

The third finger of the hand is represented by the lines leading to the passenger station, and the fourth by the road were not completed until after Easter, 1898, a very great deal of work had to be carried out between that date and the 15th of March, 1899, when passenger trains commenced to run regularly from the Marylebone terminus of the railway.

The levels of the rails at the goods warehouse, it may be mentioned, were so arranged that they are on the same level as Rossmore Road, into which the exit from the warehouse opens; while those at the Marylebone terminus for passenger



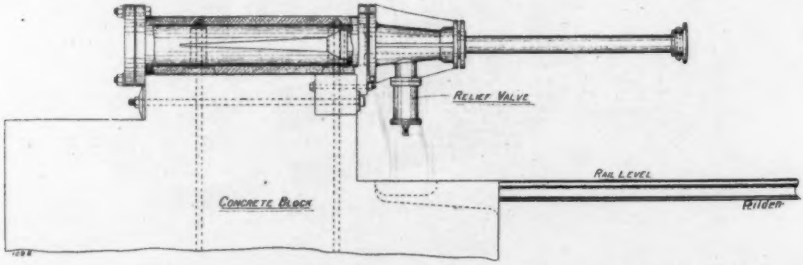
PLAN OF THE MARYLEBONE TERMINUS HOTEL GOODS STATION, COAL DEPÔT, ETC

ARRIVAL PLATFORMS, MARYLEBONE STATION.

business were fixed so that the cab road in the station was also practically the same level as the street fronting the station at the cab exit, thus avoiding any inconvenience to vehicles using either of the buildings.

The passenger station fronts upon a new street, 90 ft. in width, constructed upon what was previously Harewood Square, and is immediately to the north of the new and commodious Hotel Great Central, which fronts on the Marylebone Road, and is placed between two new streets constructed by the Great Central Railway Company, viz., Great Central Street on the west, each having a width of 60 ft.

Between the hotel and the station, a light, ornamentally constructed iron and steel roof spans the whole of the inter-



SECTION THROUGH ONE OF MESSRS. RANSOMES AND RAPIERS' HYDRAULIC SAFETY BUFFER STOPS.

This apparatus prevents or minimises any ill effects caused by trains running into the dead ends of stations at a high speed, and will receive with safety a train running at seven miles an hour. When a train strikes the buffers, the pistons are forced back along the cylinders, and the water behind the pistons has to pass through apertures in them, arranged so that they are diminished as the stroke is made. By this means a constant resistance is maintained throughout the stroke.

vening 90 ft; the half of it next to the station having a length along the station front of 90 ft., and the other half adjoining the hotel being of less width.

The station has a frontage of about 335 ft., the ground floor being occupied by the booking hall, 60 ft. × 40 ft., the waiting rooms, the refreshment rooms, and the left luggage office and cloak room. The first and second floors are laid out for general offices for the use of the Company. The building is constructed of red brick with terra-cotta mouldings, and has been designed so as to be in harmony, as to its general architectural features, with the more imposing structure of the hotel, which to some extent overshadows it. All the floors are constructed of steel joists and concrete, and the roof is also of steel, and is covered with slates. A wing on the east side contains the telegraph office, station-masters' and inspectors' offices, and lavatory. Another on the west is devoted to the parcels' department; while, north of this portion of the building, convenient rooms have been provided for the use of guards, porters, and usual terminal station purposes.

Between the east and west wings, and in front of the booking hall a large promenade has been laid out, upwards of 200 ft. in length, and of 100 ft. in width. The gentlemen's lavatories, the bookstall, the luggage weighing office occupy positions upon it; and immediately to the north, and at the eastern side of the station, are placed the platforms, four in number, the cabstand, and five lines of rails. These and the promenade are roofed over with light steel roofing almost entirely covered with glass and supported upon built steel stanchions. The first span over the rails on the east side is 40 ft. wide, and the next two have each a span of 50 ft. with a cantilever roof on the west side 15 ft. in width. This latter is only temporary, because the company owns the property to the west of the station as at present constructed as far as the new street called Harewood Avenue, and the station, it is proposed, shall eventually, as the needs of the traffic call for it, be extended westward with similar

INTERIOR OF MARYLEBONE STATION (PROMENADE).

EXTERIOR OF MARYLEBONE STATION.

HOTEL GREAT CENTRAL, ELEVATION TO MARYLEBONE ROAD.

spans of 50 ft. The roofing has been painted a light blue; and, while unpretentious in character, has a light and cheerful appearance.

All the platforms and the promenade are paved with slabs of Victoria stone, and the cab roads and new streets adjoining the station have been paved with "Jarrah" blocks.

The floors of the booking hall, parcel's office, and other important rooms have been laid with teak blocks, and the other rooms with blocks of pitch pine.

Hydraulic buffer stops have been placed at the end of each line of rails in the station.

The station is lighted throughout by electricity, but gas, on the Somzee-Grayson "Intensified" principle (which provides a light of 300 candle-power for a consumption of 10 ft. of gas per hour at the burner), has also been installed to guard against any chance failure of light from electricity.

The platforms extend from the point where the buffer stops are placed, to the Rossmore Road bridge (from which the cabs approach the station by means of a ramp), a distance of over 900 ft.

On the eastern side of the Company's property, extending from the Regent's Canal to Rossmore Road, and adjoining Park Road, the Company has been compelled by the Crown, which owns property between Park Road and Regent's Park, and by other property owners, to build a boundary wall 25 ft. in height, and use has been made of this wall to build against it the carriage sheds, the oil gasworks, etc.

The carriage shed, as far as at present built, has a length of 480 ft., with a width of 43 ft., but further additions are contemplated. It is provided with all the necessary accommodation for washing and cleaning carriages, for filling the lavatories in them with water, and filling the gas-holders with gas.

The gas is manufactured at the oil gasworks, which are in close proximity to the carriage shed, and which have been fitted up with the most modern machinery and appliances for that purpose.

A platform for handling milk business, 27 ft. in width and 500 ft. in length, has been made between the main passenger lines and the carriage shed; and adjoining it have also been provided carriage and horse docks, &c.

The signalling accommodation for the Metropolitan Division consists of a small signal cabin at Hillgrove Road; a goods cabin at St. John's Wood Road with 94 levers, and space for 16 additional levers; a coal cabin at Grove Road, the main passenger cabin, half-way between the Regent's Canal and Rossmore Road bridge, and another cabin on the westerly platform at the station. The usual necessary signals are provided, and in three places bridges of 110 ft. have been built across the lines to carry them.

The contract for the whole of the work for the Metropolitan division was placed with Mr. J. P. Firbank, M.P., and the steel work has been done for him by various Contractors; among whom may be mentioned Messrs. Findlay & Co., the Cleveland Bridge Company, Messrs. Handyside & Co., the Tees-side Bridge and Engineering Company, Messrs. Keay & Co., Mr. Jesse Tildesley, the Butterley Company (of Derby), Messrs. Deane and Ransome, and Messrs. Homan and Rodgers.

Messrs. Mellowes & Co. and Messrs. Helliwell & Co. have carried out the glazing of the roofs.

Messrs. Tannett, Walker & Co. have supplied the hydraulic machinery and connections.

Messrs. Royce & Co., the electrical work for "Railway Lighting, Limited."

Messrs. the Railway Signal Company supplied and erected the signal work.

Messrs. Abbott & Son, of Chesham, manufactured and supplied the whole of the joiners' work, including the handsome oak panelled booking-office screen.

Mr. Charles Hill, of Leicester, carried out the plumbing, painting and glazing.

On the construction of this railway, which was entirely through London clay, there were employed upwards of 3,000 men, and this continuously from when a virtual commencement was made in May, 1896, until the opening for coal traffic, in July, 1898. Since the latter date—the tunnels and covered way being finished—the number was slightly reduced.

Thirteen locomotives, six portable

engines, twenty-three steam travelling cranes, one steam navvy, and the usual ordinary railway Contractors' plant of mortar pans, tip wagons, etc., were fully employed, night and day.

On Sunday it was not always possible to put the locomotives out of steam. Considering the limited space in which so many locomotives operated, there is satisfaction in the fact that during the most foggy weather there was not a single collision. Upwards of forty Wells' lights were used, and they, with due regard to working the trains, effected this desirable result. Nearly 600 permanent way wagons were employed in removing the excavation from St. John's Wood to Neasden, the Metropolitan Railway Company providing locomotives until the line was opened for coal traffic, when the contractors' engines did the haulage. There were eight miles of temporary roads, and more than three miles of Decauville light railway, with special small trucks for working thereon. In the work there were used:

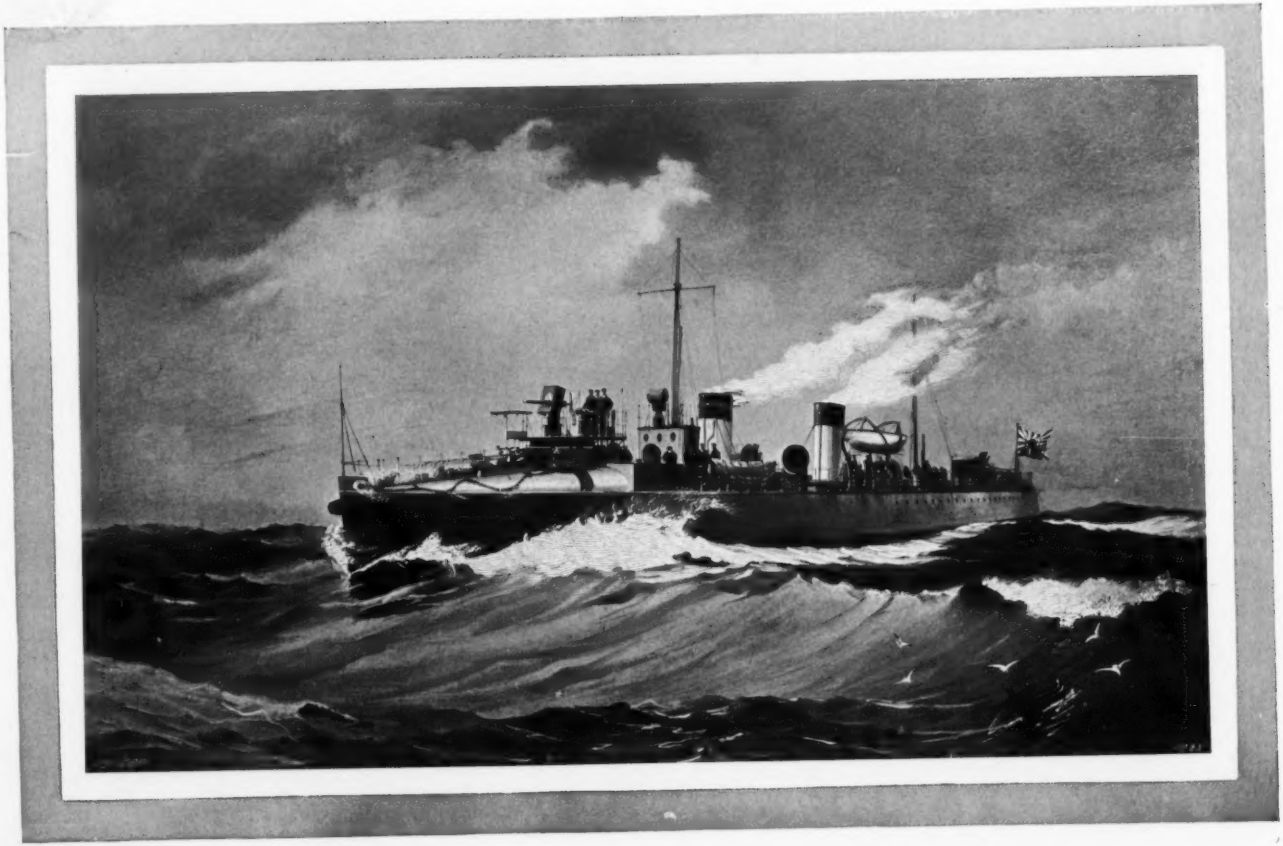
91,000,000 brindle and red bricks,
50,000 tons of cement,
13,000 tons of steel and iron.

From end to end, the work shows the most complete example of Engineering success. There is not a sign of weakness in any respect: all the work is solid, sound, and without a flaw.

(To be concluded in the next issue.)

THE CARPENTERS' SHED, ALPHA ROAD, WHERE THE FIRST SOD WAS TURNED BY LADY WHARNCLIFFE, NOV. 13TH, 1894.

SUP



JAPANESE IMPERIAL NAVY TORPEDO-BOAT DESTROYER "USUGOMO."
Builders, J. I. THORNYCROFT & Co., *Chiswick.*

MACHINERY APPLIANCES AND PROCESSES.

"Every part and side of our life, from the cradle to the grave, has been touched and tended by the inventor and manufacturer. His works are as numberless as the sands of the sea, but the onward rush of Science and the Arts opens up new fields of discovery and enterprise as each day dawns. Let us choose here and there among thousands, and in choosing take the best as far as in us lies."

IMPERIAL JAPANESE NAVY TORPEDO-BOAT DESTROYER "USUGOMO."

JOHN THORNYCROFT & CO., BUILDERS.

WE have pleasure in presenting as a special supplement plate to this issue an illustration of the torpedo-boat destroyer *Usugomo*, built by the well-known firm of Thornycroft & Co., for the imperial Japanese navy.

This boat is one of a series ordered by the Japanese authorities, and the boat under notice is in every way worthy of the high reputation its constructors have attained in the many years during which they have given their attention to rapid marine navigation. The dimensions of the *Usugomo* are as follows:—Length, 210 ft.; breadth, 19 ft. 6 in.; draught, 7 ft.; indicated horse-power, 5,700; speed, 30 knots.

The vessel is built of steel throughout, the propelling plant, consisting of two complete sets of engines of the type invented and patented by Mr. Thornycroft, driving twin screw-propellers. Each set of engines has one high, one intermediate, and two low-pressure cylinders, supported on steel columns somewhat out of the perpendicular, and so arranged that the thrust of the rods acts simultaneously on the cranks from opposite directions in order to obviate vibration in working. The engines are, of course, supplemented with condensers, circulating pumps and engines, air and feed pumps in the usual way. Messrs. Thornycroft & Co. have also fitted the blowing engines, steam-steering engine, air-compressing machinery, electric light and distilling machinery.

Steam is supplied by three of Thornycroft's water-tube boilers, which give ample steam, and are stated to be remarkably efficient in speedy generation. These boilers are fitted respectively with automatic feed regulating gear: viz., a device for automatically regulating the supply of feed-water by the action of a steel float situated in the upper barrel of the boiler, which opens or closes the valve through which the boiler is filled. Each boiler is capable of being worked independently, and is adapted for a pressure of 220 pounds per square inch.

The armament of the *Usugomo* consists of one 12-pounder 40 calibre quick-firing gun and five 57-millimetre quick-firing guns. The torpedoes are fitted in two revolving gears placed on deck aft and arranged for discharging 18 in. Whitehead torpedoes.

The full complement of the *Usugomo* of all ranks is 54 in number, and ample accommodation is provided for them, considering the limited space at command on this type of vessel.

NEW TWIN-SCREW HOPPER DREDGER.

ON page 428 we reproduce a photo of the twin-screw hopper dredger, *No. 1 Shunkai Maru*, which Messrs. Wm. Simons & Co., Ltd., of Renfrew, have just completed for the Osaka Harbour Board, Osaka. The dredger, which is to be employed in the improvement of the Osaka harbour, is classed at Bureau Veritas, and was constructed under the inspection of Mr. C. Shiba, of London, inspecting engineer of the Osaka Harbour Board in this country. She has a hopper capacity for 600 tons of spoil, and the buckets are of ample capacity to raise and discharge into the hopper the full load of free soil in one hour. The buckets have a maximum dredging depth of 36 ft. below the water level, and are also arranged to cut the vessel's own floatage. The propulsive power is supplied by two sets of com-

TWIN-SCREW HOPPER DREDGER NO. 1 "SHUNKAI MARU." HOPPER CAPACITY 600 TONS.

pound surface-condensing engines, and two mild steel boilers of 120 lb. working pressure, either set of engines being capable of driving the dredging gear. The hopper doors are raised by steam appliances. Powerful steam-winches are placed at bow and stern for manœuvring the dredger when at work.

The vessel is lighted throughout by electricity, and comfortable quarters are provided for officers and men.

At the dredging and steaming trials of the vessel, on the Clyde, results considerably in excess of the contract requirements were obtained. In thirty-five minutes' dredging, 600 tons were raised and discharged into the hopper, or, say, 40 per cent. over the contract conditions. On the measured mile the mean speed obtained was over eight knots, being 1 knot full over the conditions stipulated in the contract.

The vessel will leave shortly, under her own steam, on her voyage to Osaka.

READERS of "FEILDEN'S MAGAZINE" are reminded that the Editor will be pleased to hear from them with advance particulars of any new machinery or specialities they may be bringing out or interested in.

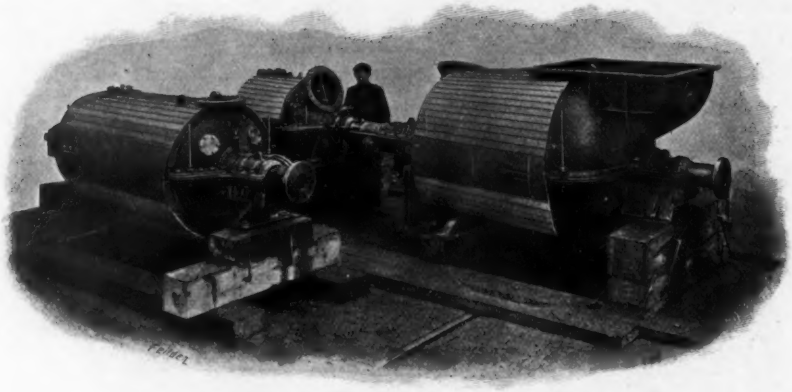
H.M. TORPEDO-BOAT DESTROYER "VIPER."

By the courtesy of the Parsons Marine Steam Turbine Company, Limited, we are enabled to publish on the succeeding page a reproduction of a photograph showing the turbine-propelled torpedo-boat destroyer *Viper* steaming at the rate of 35½ knots per hour at sea. This is the highest speed which has ever been attained in steam navigation, and as a consequence the extraordinary performance of this vessel has aroused universal attention.

The principle of the *Viper's* propelling power has been already made widely public through its experimental predecessor, the *Turbinia*. The *Viper*, however, is intended to take a place as a practical example of the new system of propulsion in H.M. Navy, where its success may already be regarded as assured.

The *Viper* has been built to the order of the British Admiralty by the Parsons Marine Steam Turbine Co., Ltd., of Wallsend-on-Tyne, and has undergone two preliminary

H.M. TORPEDO-BOAT DESTROYER "VIPER," STEAMING AT THE RATE OF 35¼ KNOTS PER HOUR.



TURBO MOTORS OF H M. TORPEDO-BOAT DESTROYER "VIPER."

trials at sea, several officials of the Admiralty being present on the latter occasion. The maximum speed attained was 35·5 knots; the mean speed on four consecutive runs being 34·8 knots. As the speed required by the contract was only 31 knots, it will be seen that the vessel has already exceeded the requirement by 3·8 knots—a result which must be considered as eminently satisfactory, and entitling the vessel to be regarded as the fastest craft afloat.

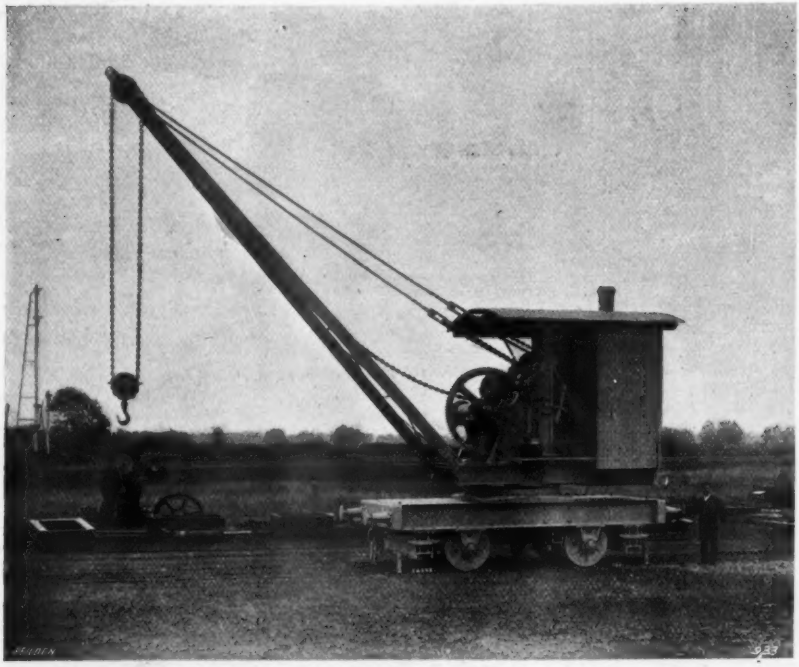
The vessel is 210 ft. long, with 21 ft. beam, and 12 ft. 6 in. deep, the displacement being 350 tons. There are six turbo-engines, four of which are capable of developing 12,000 h.-p., the other two being used for going astern. There are altogether four shafts driven direct from the motors, each shaft carrying two propellers. The arrangement on both starboard and port sides is that the high-pressure turbine drives the outer, and the low-pressure turbine the inner shaft. On the inner shaft a reversing turbine is fixed, which runs idle when the boat is going ahead, and when it drives the ship sternward the forward turbines are idle. The speed astern is 15½ knots.

Apart from its speed, the chief characteristic of the turbine-propelled vessel is the absence of that vibration which is felt so severely in high-speed craft of the ordinary type. In the turbine boat there is no motion of the kind inseparable from the action of reciprocating engines. The high rotary speed and multiple propellers have the effect of almost entirely eliminating vibration, which would appear to render steam-turbine machinery specially applicable to fast passenger vessels, steam-yachts, and cross-channel boats.

IMPROVED LOCOMOTIVE STEAM CRANE.

THE improved steam crane illustrated on page 431 is designed for weights up to ten tons with a sixteen feet radius. It was designed by the Bedford Engineering Company, Bedford, and represents the very latest practice in this class of engineering. It can be fitted with lifting and slewing gear for turning in either direction without stopping or reversing the engines, and, if required, steam derrick motion for lowering and raising the jib, and locomotive gear for moving the crane along the rails by its own power.

The travelling carriage is built of steel girders, supporting the centre casting, which is bored to receive the post. The centre casting has a race turned on it to receive a spur roller path, upon which the superstructure revolves. This path, being loose and free to revolve, avoids the risk of breaking the gear, and also acts as a friction brake when slewing. The post is a steel forging, and the base of the superstructure is formed of two rolled steel girders, connected with cast-iron transomes fitted with four antifriction rollers, and of sufficient length to carry the tank at the rear. The cast-iron side cheeks are bolted to the girders, having open bearings for the crank shaft and planed seatings for the cylinders. The hoisting gear is single purchase, actuated by a steel pinion sliding upon the crank shaft; the hoisting barrel runs loose upon its shaft, the latter being fixed between the side cheeks and acting also as a stay. The engines are 8 in. diameter × 12 in. stroke, fitted with improved link motion reversing gear, taking steam from a boiler of the vertical cross water tube type constructed



IMPROVED STEAM CRANE BY THE BEDFORD ENGINEERING COMPANY, BEDFORD.

entirely of Siemens-Martin steel, working at a pressure of 80 lb. to the square inch.

The whole construction with its mechanism is a worthy example of the best type of British design and workmanship.

SOME OLD ENGLISH LOCOMOTIVES.

We are indebted to Mr. Alfred R. Bennett for the photographs on next page of some very old locomotives of English design and build, which are still running on the Main-Neckar Railway in Southern Germany. Eight of these engines, of which seven are yet working, were built by Messrs. Sharp Brothers and Company, Manchester, in 1846-7.

They were then all passenger engines, having single 5 ft. 6 in. driving wheels, the trailing wheels being in front of the fire-box. In 1875 they were re-built at Carlsruhe and Darmstadt, half as goods engines with four 4 ft. 4 in. coupled driving wheels in front of the fire-box, and half as passenger engines with four 5 ft. 6 in. coupled wheels, the trailer being behind the fire-box. It is understood that all the 5 ft. 6 in. wheels are the original ones, those of the four engines converted to goods being utilised as trailers in the four altered to coupled passenger. The original aspect of the engines, apart from the driving wheels, motion, buffers, chimney, sand-box, cab, Westinghouse brake and its exhaust pipe, remains practically unaltered. The cylinders are 14½ in. by 22 in., heating surface 840 sq. ft., weight in working order 25½ tons, and working pressure 100 lbs.

Fig. 1 shows one of the goods engines, built in 1846, shunting in the Heidelberg goods-yard on May 24th, 1899; whilst Fig. 2 shows "Sharp No. 6" passenger engine, built in 1847, coming out of the Heidelberg engine-shed on the same day, preparatory to taking away a train for Friederichsfeld. In view of the recent importations of American engines, the longevity of these early English specimens is not without interest.

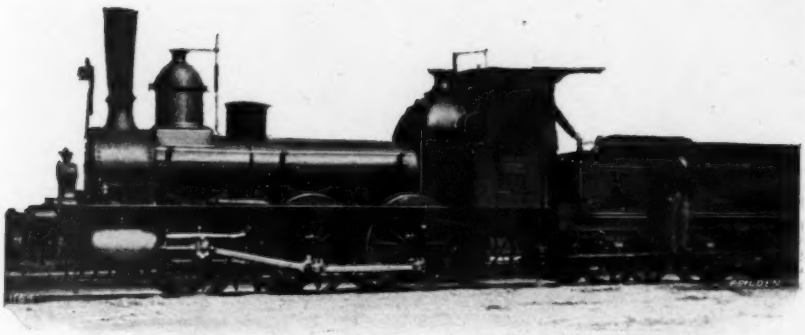


FIG. 1.—GOODS ENGINE (BUILT 1846). SHUNTING IN HEIDELBERG GOODS-YARD, MAY 24TH, 1899.

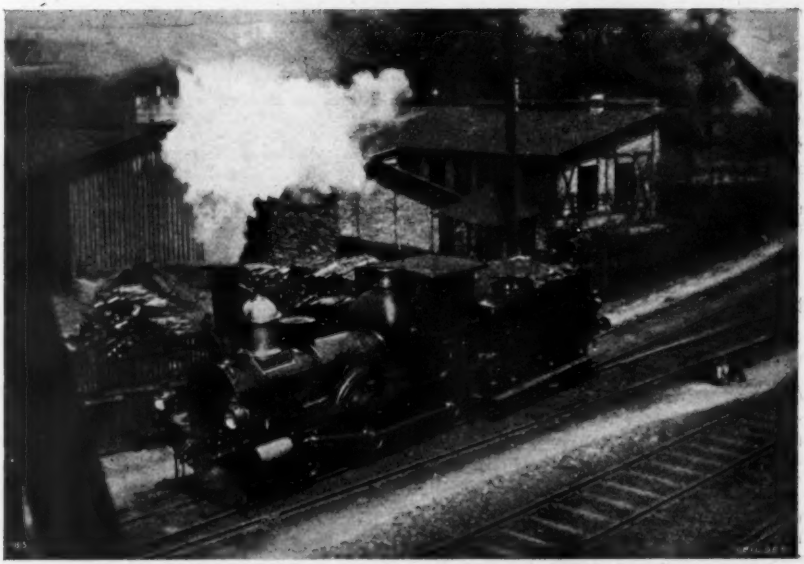


FIG. 2.—"SHARP NO. 6" PASSENGER ENGINE (BUILT 1847) COMING OUT OF HEIDELBERG ENGINE-SHED PREPARATORY TO TAKING A TRAIN, MAY 24TH, 1899.

WATER COOLING OR CONDENSATION.

THERE can be no doubt that a great number of main-driving engines now in use could be made to work with a considerable degree of superior economy by

FIG. 1.—TOWER WATER-COOLER.

attention to their condensing plants. Owing to defective arrangements, due generally to scarcity of cooling water, the vacuum is seldom what it ought to be, and what it would be under proper circumstances. The Klein Water-Cooler, which has been pushing its way with increased vigour during the past few years, certainly offers in a comparatively inexpensive as well as most effectual way a solution of a difficulty which has been perplexing many mills and manufactories.

The Klein Water-Cooler is really a scientific development of the ordinary cooling pond. But whereas the cooling pond, which depends for its action on surface radiation only, requires a large area to be in any way effectual, the Klein plant requires but a small space for its disposal, and is far more efficient in every respect. The principle of the Klein Water-Cooler consists in distributing the condensing water over the largest possible area, so as to bring it into contact with the atmosphere to the greatest extent possible. To this end the water is made to trickle over wooden laths built up in stacks, the direction of the flow being changed as often as possible. In the ordinary course, the hot water is pumped by air pumps to the top of the stack, where it takes its downward course to the well underneath. During its progress it is met by a stream of air produced either by induced draught or a centrifugal fan, by which means the water can be cooled down from a high temperature to one as low as 62 degrees Fahrenheit.

It is claimed by the makers that the saving resulting from the use of these coolers will speedily cover the outlay, and that they can be installed without stopping machinery or interfering with the steam plant in any way. The Klein Engineering Co., Ltd., have recently made some very large installations of their apparatus, some illustrations of which are reproduced on this and the following page. Fig. 1 shows a Klein enclosed cooler on the induced draught system, whilst Figs. 2 and 3 show types of the horizontal form where air is supplied by mechanical means. The Klein system of water cooling is rapidly becoming recognised as an indispensable adjunct to a well-ordered steam plant.

The Editor of FEILDEN'S MAGAZINE

Will be pleased to consider Literary Contributions dealing with subjects within the purview of this Magazine, and to make satisfactory arrangements with Contributors if MSS. be accepted for publication. High-class engravings from photos and drawings will be prepared free of cost to the writer.

A limited number of the First Volume of FEILDEN'S MAGAZINE, magnificently bound, are still to be obtained. Prices—in handsome cloth case, 21s. 6d.; in half calf or morocco, 25s. 6d.

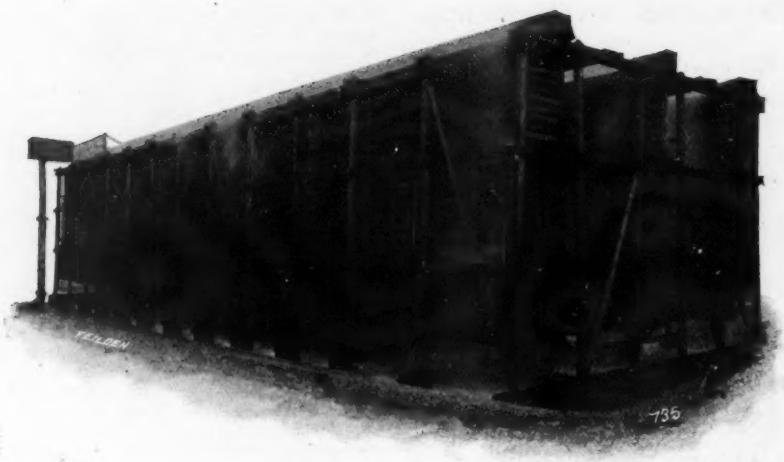


FIG. 2.—OPEN TYPE WATER-COOLER.

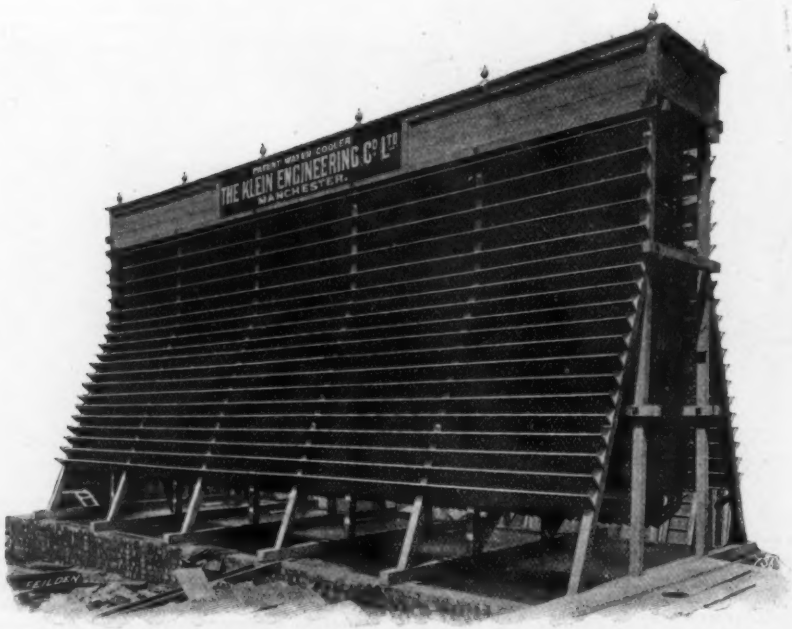


FIG. 3.—OPEN TYPE WATER-COOLER, FITTED WITH LOUVRES TO PREVENT THE WATER SPRAYING.

NEW SYSTEM OF RAILWAY SIGNALLING.

FEW other branches of industry have been the subject of so much invention that, owing to a variety of circumstances, but chiefly to inherent defects, has proved futile as that associated with railway signalling. The invention under notice, however, has gone far beyond the experimental stage, having been in successful operation under every condition of every-day practice for a considerable period. The system of railway signalling as at present employed can only, especially under some of its conditions, be described as barbarous. The method of communicating with passing trains by means of "fog-signals" must, sooner or later, give way to more scientific methods. It would appear that the device invented by Mr. Wynford Brierley, and now being introduced by Messrs. Saxby & Farmer, Ltd., the well-known signal makers, possesses claims that entitle it to the serious consideration of those chiefly interested in the subject. His apparatus, as we have already stated, has undergone a severe and prolonged test for about two years on a section of 25 miles of the Great Northern Railway, and, further, has been accepted by the Board of Trade, one of whose Inspectors, Colonel Yorke, has reported favourably on its utility and satisfactory working.

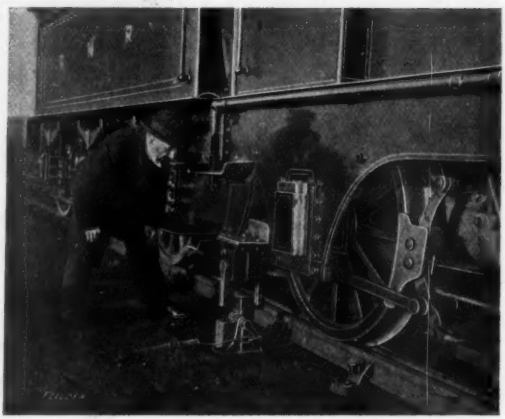


FIG. 1.—THE POSITION OF THE ROCKER WHEN THE SIGNAL IS AT DANGER.

FIG. 2.—THE POSITION OF THE ROCKER WHEN THE SIGNAL IS AT "ALL RIGHT."

Among the chief causes of railway accidents the apparatus under notice is intended to prevent, are fog collisions, mistaking or over-running signals by drivers, and accidents through trains becoming uncoupled, etc.

The photographs give a general idea of the mechanism through whose action a signal can be either conveyed to or from the driver of the engine when running at full or at any other speed. In Fig. 1 the apparatus is shown fixed on the engine, with a lever or trigger passing over the contact rocker on the way. The rocker is fixed on a sleeper a short distance from the rail, and by means of a branch wire connected

with the lever of the rocker and the ordinary signal as shown.

The position of the rocker shown (Fig. 1) is the normal one of "Danger." The lever is held in a vertical position by an ingenious volute spring with coils in reverse order to each other. This spring is riveted to a stud, to which the lever is attached and lugged to a bolt passing through the box; fixed at the other end of the stud is a vulcanised fibre cam, which, when the lever is operated by contact with the rocker, presses two pairs of springs together inside the box. An electric circuit is thus closed, and a bell on the engine put into continuous action; a battery of six dry cells arranged in parallel series being carried on the engine for this purpose. At the same time, a red disc is brought to the front of a window in the bell, thus giving a visual as well as an aural signal. This bell continues to ring until stopped by the driver, which is done by pressing a plunger at the side; simultaneously the red disc disappears, a white one taking its place.

FIG. 3.—THE BELL AND INDICATOR ON THE ENGINE.

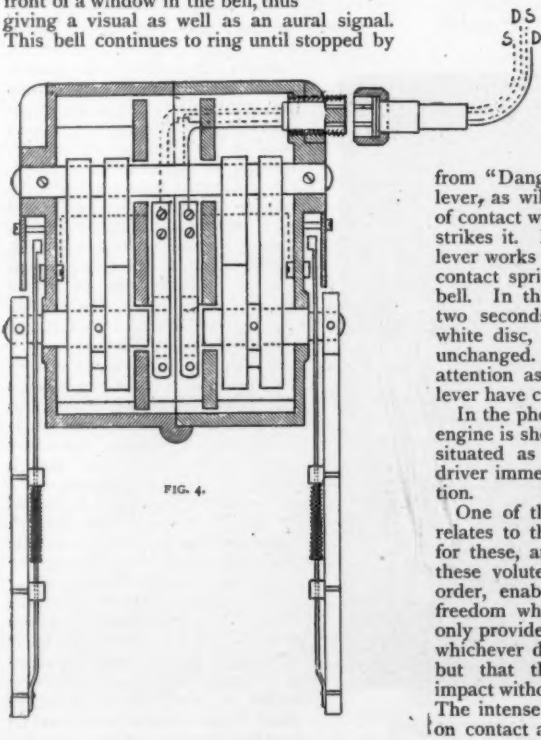


FIG. 4.

We show in Fig. 2 the position of the rocker when the signal has been altered from "Danger" to "All right." The inner lever, as will be seen, is now out of the line of contact with the rocker and the outer lever strikes it. It may here be stated that each lever works on its own axis and has separate contact springs carrying the current to the bell. In this case the bell rings for about two seconds only, and the position of the white disc, indicating "All right," remains unchanged. The bell stops ringing without attention as soon as the oscillations of the lever have ceased.

In the photograph (Fig. 3) the bell on the engine is shown, which, as will be seen, is so situated as to be heard and seen by the driver immediately on being put into operation.

One of the chief points of the invention relates to the volute springs. It is claimed for these, and apparently with justice, that these volute springs with coils in reverse order, enabling the levers to move with freedom when they strike the rockers, not only provide for their acting equally well in whichever direction the train may be going, but that they successfully overcome the impact without danger of breaking the levers. The intense vibrations set up in the springs on contact are gradually, yet rapidly, eased

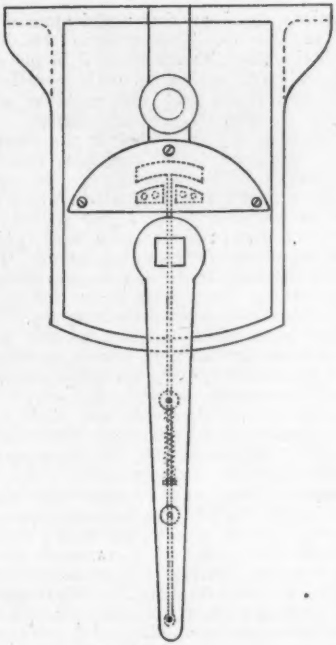


FIG. 4A.

off, leaving the levers, when the oscillations have ceased, in their normal vertical position. This is proved by the fact that up to the present there have been no levers broken by their impact with the contact rockers; but should a case of this kind occur after prolonged usage, or should even a lever bend out of line of contact with the rocker, the driver is immediately apprised of the circumstance.

This is effected by a very simple device,

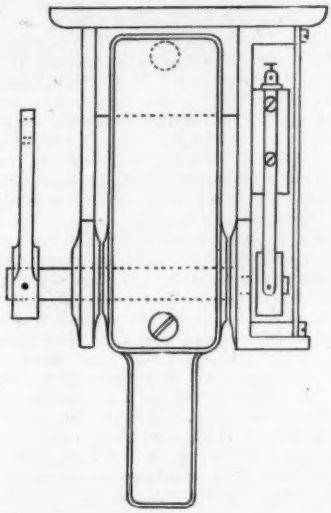


FIG. 5A.

illustrated in Figs. 4 and 4A. Taking the case of a lever breaking or bending, the boss on the top of the bar attached to the lever would drop on the two brass studs (Fig. 4A). By this, an electric circuit would be closed and the bell on the engine set ringing, which in this case could only be made to stop by disconnecting the bell from the circuit itself and not by the plunger as in the case of an ordinary danger warning, so that a clear, unmistakable distinction between the two signals is given. The contact springs also inside the box are in duplicate, and should one set get out of order, the defect would be at once notified by the bell (as in the previous case), but here the apparatus would not be so disabled as not to act. The volute or lever springs, too, provide their own tell-tale in case of breakage or other damage. The levers are held motionless by the normal tension of the

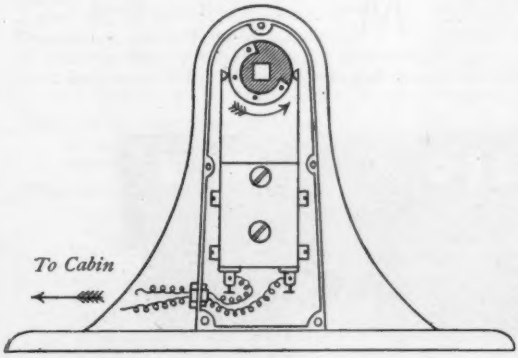


FIG. 5.

springs, and should a spring break the lever would at once commence to oscillate through the ordinary motion of the engine, and the vulcanite cam previously referred to would press the contact springs together and give the alarm by setting the bell ringing continuously.

It will be seen, therefore, that every contingency has been foreseen and provided for.

With regard also to the rocker on the road, by means of a "Repeater," shown by Figs. 5 and 5A, the signalman knows whether the rocker has been moved to its true position—whether the ordinary signal wire, to which a branch wire from the rocker is attached, has contracted, or expanded, or broken, thus being a safe check or guide to the signalman when he cannot see the signals in consequence of fogs, or from other causes. Reference to the contact springs, shown by the diagram in Fig. 5, will explain how this is done. The disc is of vulcanite fibre, or an insulating one, upon which is fitted a brass plate covering two-thirds of the periphery of the disc. One of the contact springs, it will be observed, rests upon the insulating part of the disc, and the other on the brass plate. Whilst the rocker is being moved from one position to another both springs come in contact with the brass plate, thus carrying the current to the bell until the rocker reaches its proper position, when it ceases. If anything should occur preventing the rocker from rising or falling to the proper positions, both springs would remain in contact with the brass plate, thus putting the bell in the cabin in continuous action.

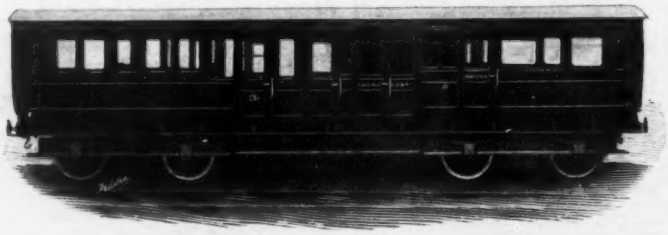
Fig. 5A shows an end view of the rocker, with the chamber of the "Repeater," which is dust-proof and water-tight. As in the case of the levers, nothing up to the present has occurred proving the absolute necessity of the "Repeater." It can, however, be readily applied where thought desirable.

Connected with the rocker, also, at junctions, etc., is another useful appliance—a signal selector. This consists of a multiple lever shaft, which may be used in place of the ordinary single shaft, each lever being separately connected to the respective wires which operate the various signals. By means of a key embedded in the shaft of the rocker, and quadrant slots recessed in the bosses of the levers, only the signal required to be given is operated. The driver thus knows whether the signal is "on" or "off" on the particular road he is going, whether he can see the signals or not. This device prevents the driver from mistaking or over-running the signals, a not infrequent occurrence, even when there is no fog. The complication which would otherwise arise from a multiplication of contact rockers is also thus avoided, and a perfectly safe and simple signal selector provided.

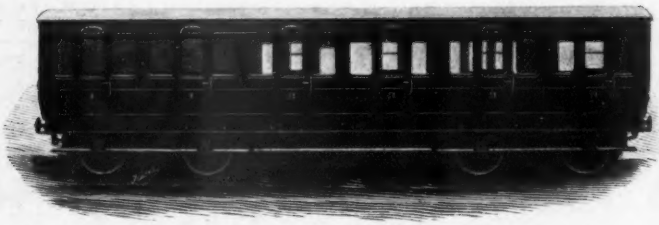
A number of other purposes, obvious to those practically acquainted with railway practice, may be served by the apparatus we have described. Among these is an extemporised attachment by which platelayers and others on a line can warn an approaching train of their vicinity, and engine-drivers may become aware by a variation of the same means whether cross-gates are open or closed. We understand that Mr. Brierley's invention has been patented in all the principal countries of the world, and that it is creating considerable interest in foreign railway systems, as well as in England.

AN EXPERIMENTAL ELECTRIC TRAIN

MUCH public interest is felt in the approaching conversion of the Metropolitan District Railway system into an electric line, and we have pleasure in giving some particulars of the type of carriage



MOTOR CARRIAGE CONSTRUCTED FOR THE EXPERIMENTAL ELECTRIC TRAIN OF THE METROPOLITAN DISTRICT RAILWAY.



ORDINARY CARRIAGE OF THE EXPERIMENTAL ELECTRIC TRAIN OF THE METROPOLITAN DISTRICT RAILWAY.

it is proposed to adopt under the new auspices.

The special electrical train in question was built by Messrs. Brown, Marshall & Co., Ltd., of Birmingham, and it consists of six carriages, each 39 ft. 6 in. in length and 8 ft. 3 in. in width. The latter dimension affords 3 in. more space to the passengers than the carriages now employed, a small, though quite appreciable, alteration to the travellers.

The motor carriages are situated at each end of the train, and these are divided into three sections. One section contains the motor and its controlling gear and accommodation for the driver and guard. Another section is devoted to luggage, whilst the main body of the car forms one large passenger compartment with one door on each side. The other four carriages are divided into compartments with side doors in the usual way. It will thus be seen that no attempt has been made to imitate American practice in the seating accommodation. The train is divided into first, second, and third classes, there being accommodation for 80 first-class passengers, 96 second, and 136 third-class, or 312 altogether.

The weight of the train complete is approximately 190 tons, passengers included. The motor carriages at each end of the train weigh 50 tons each, or more than half the weight of the entire train.

The carriages, of course, are fitted with the electric light, furnished by glow lamps, two lamps being placed in each compartment; and in the case of third-class carriages two over each division. The bogie type is employed for the cars, there being two four-wheeled bogies placed twenty-five feet apart with a wheel base of 7 ft.

The unanimous opinion

of the British and oreign press, the world's leading engineering and scientific authorities, the industrial and commercial community, and the public generally, is, that FEILDEN'S MAGAZINE is

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What more could be wanted? The Proprietors, however, are not satisfied. Busy, active brains have been at work night and day on plans to see how the already very high standard of excellence of the Magazine can be still further enhanced. As a result

1900 will see innovations

of a character which will give this Magazine a greater value both to the technical and general reader than any other publication extant. It has already

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of any monthly industrial-engineering Magazine in the United Kingdom or abroad. The Proprietors aim at making it double that of any other high-grade technical journal. It can and *will* be done.

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to that end. Meanwhile the Proprietors advise all the present readers to recommend their friends to take and *preserve* copies of FEILDEN'S MAGAZINE. The special articles by the world's experts and new features to be shortly introduced will cause all back numbers to be sought for with increasing interest for binding.

Watch the pages from cover to cover.

WORKSHOP PRACTICE

The purport of this section of FEILDEN'S MAGAZINE is to give the skilled mechanic in our great industrial establishments an opportunity of bringing his practical ideas and experience into print. Inventive capacity and careful thought on the part of the workman is what we desire to encourage and foster. To this end we invite skilled mechanics, foremen, under-foremen, and heads of departments, to communicate practical suggestions, which if accepted will be suitably paid for. Wherever possible, drawings should accompany the contribution; rough sketches will suffice, as, when draughtsmanship is at fault, we will do all that is necessary to render them fit for reproduction. Nothing will be too poor for a careful inspection. It will be seen that those contributions which appear in this section show distinct merit, and are both interesting and instructive.

❀ ❀ ❀

Saw-Draughting.—This is an art or device practised in the pattern-making and joiners' shops, but more for temporary work, such as circled webs or flanges on a temporary bracket for a repair, or putting an extra thickness on the rim of wheel, pulley, etc., but when well done is quite effective for standard work, and is both cheap and labour saving. Although a very simple and well-known plan it is unfortunately, even with experts, often done without any method. It is required to make a curved web like that shown in sketch A. Size 22 in. long, 1 in. thick, and 6 in. in depth, having radius 18 in. = R, and as opposed to the method of marking out with trammels on a large piece of wood (fig. A) and then cutting the segment with a band-saw, a piece of finished stuff a little longer than size given, is taken, but of the exact thickness and depth required, and with a hand-saw several cuts are made at equal pitch, and to an equal depth into the wood, as shown in fig. B, and bent to the required circle, but if it is done without method—the pitch being a mere guess—it may not bend to the degree wanted, and then trouble arises and time is wasted as a result; while if it is overdone—bending much beyond requirements—then there is no stability whatever if it is unsupported. We obviate all this, however, by carefully studying the question and by making a rule that applies to all work of the kind, and to assist the artizan, to whom cut-and-dried rules are too complex, we will explain the practical working of the problem before us, which being but a part or segment of a whole circle, may seem difficult. To find the pitch or distance between each saw-draught, for any length within any circumference, and for any thickness of wood, the wood is considered as bending round the whole diameter, as given by the radius, which in the example is 36 in., and the wood being 1 in. thick we have another diameter of 38 in. Now the difference between the circumferential sizes of these diameters is about 6¼ in., and it is found that when we make saw-draughts sufficient in number that their collective widths will, when cut out of the wood, amount to 6¼ in., we get the exact bending proportion. And if the wood is the length of the larger circumference we

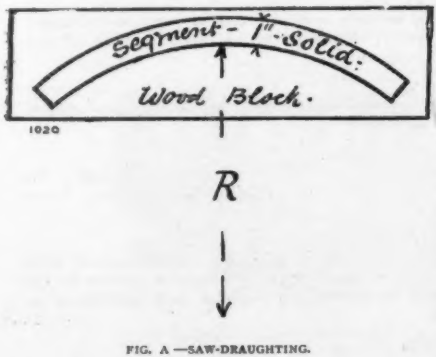

FIG. A.—SAW-DRAUGHTING.

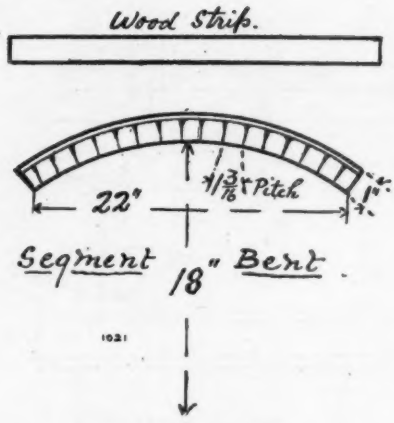

FIG. B.—SAW-DRAUGHTING.

can thus make a true ring. Dividing 6½ in. by the width or thickness of the saw we get the number of draughts to be made, which, if the saw is $\frac{1}{16}$ thick gives us 100; and again dividing the total length of wood into 100 parts we find the required pitch is exactly $1\frac{3}{16}$ in. From this, and from other calculations, we arrive at the following simple rule:—

$$\frac{D.}{T^2 \div S.} = \text{Pitch.}$$

When D. is the inside or smaller diameter.
T. is twice the thickness of wood.
S. is the thickness of saw.

oooo

A Useful Lathe-Chuck.—The small lathe-chuck which is here illustrated will be found very useful when using a lathe for the purpose of drilling holes through round or flat bars at right angles to their axes. Fig. 1 shows the chuck in section, and attached to the poppet-head spindle of a lathe by means of a set screw. It consists simply of a boss *A*, a disc portion *B*, and a V-slot *C*,

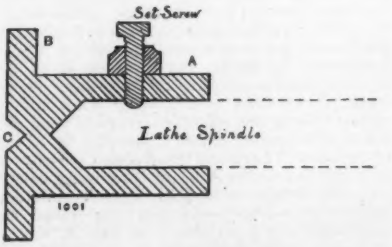

FIG. 1.—A USEFUL LATHE CHUCK.

which is cut right across the face of *B*, and into which slot the bar which it is required to drill through can rest. In place of the V-slot other shaped slots or recesses may be made in the portion *B* to suit any section of bar it may be desired to drill. Such a device will be especially appreciated by those who very frequently have to use the lathe as a drilling machine.

oooo

Simple Jigs for Forming Spheres.—Many devices have from time to time been adopted for the purpose of turning brass, iron, or other metal spheres. The following, however, are interesting, since they illustrate both British and American methods, and are both simple in construction and easily made. The American method is shown in Fig. 1, and is in the form of an attachment to a drilling machine. Referring to the diagram, *A* is the spindle of an ordinary drilling machine; *B* a bevel wheel, which forms part of the said machine; *C* is the ball or sphere

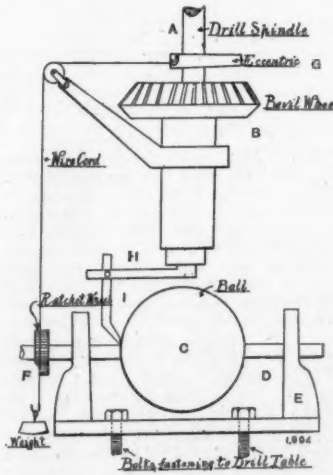

FIG. 1.—JIGS FOR FORMING SPHERES.

it is desired to turn, which is mounted on a mandril *D*. This in turn is carried on a suitable bracket or frame *E*, which is bolted to the table of the drilling machine. At the end of the mandril *D* is a small ratchet wheel *F*, and having its pawl worked by a cord and weight off the eccentric *G*, which is attached to the drill-spindle as shown. In place of the ordinary drill-bit is fitted a cranked tool-holder *H* carrying a tool *I*. It is obvious, therefore, that the combined rotation of the sphere on its mandril and of the drill-spindle which carries the cutter will present the

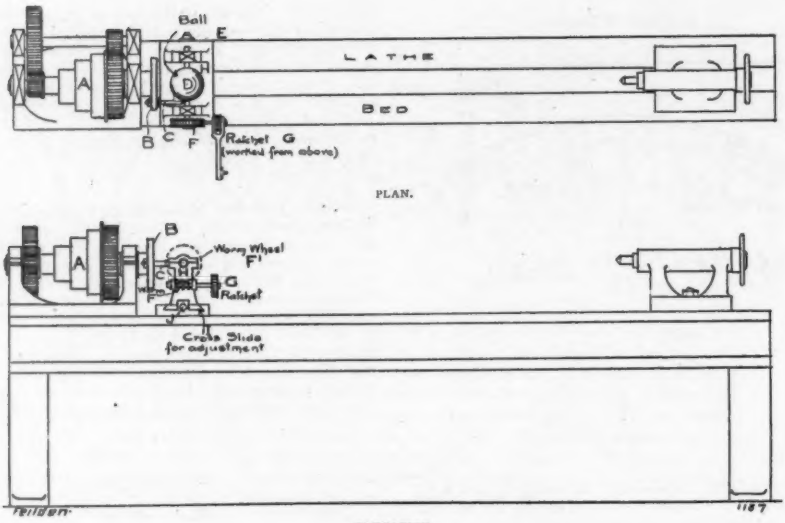

FIG. 2.—SIMPLE JIGS FOR FORMING SPHERES.

entire surface of the sphere to the cutter, except at the poles, and thus effect the purpose desired. Such a device will be found very satisfactory for turning brass balls or spheres up to about 3 in. diameter, but for larger sizes, and especially when made of harder material, such as cast-iron, the device described below will be found more satisfactory. Fig. 2 shows the English method in plan and elevation, from which it will be noted the arrangement in this case forms an attachment to a lathe. The principle adopted is practically the same as in the previous device—viz., the ball or sphere to be turned is mounted on a mandril revolving in a plane at right angles to that of the cutting-tool; but there are some points in detail possessed by the English method which give it a considerable advantage over the other. Referring to the diagram, *A* is the fast-head of an ordinary lathe, *B* a driving-plate which forms a chuck to carry the cutter *C*. This cutter is provided with suitable adjustments from the centre of the chuck outwards to allow of fixing it in different positions for turning spheres of different diameters. *D* is the sphere to be turned, mounted on a mandril *E*, and is rotated by the worm and worm-wheel, *F* and F^1, and ratchet-wheel *G*, which is worked from an overhead arrangement. The mandril *E* is carried on a suitable frame *H*, which is provided with a cross-slide *I* and adjusting screw *J*. This enables the sphere to be brought into exact position, since it frequently happens that it is sometimes driven further on the mandril at one time than another. These various adjustments referred to, together with the combination of worm-gear with ratchet, give an advantage to the British method. As an example of the size of lathe required to machine various sized spheres, it may be stated that a 10-in. lathe with such an attachment will easily turn cast-iron spheres up to 7 in. diameter, or even larger.

Adapting a Lathe for Planer Work.—Some years ago I had to machine a few hundred castings, about 3 ft. long by 12 in. by 12 in. at A, and 24 in. by 3 in. at B. I had to face these at A, also to bore a 1½-in. hole through the centre of the casting at A and O (see Fig. 3). Having neither a planer nor a drilling machine available, the following method was adopted: A spare face-plate C, part of an old slide-rest D, with a tool-box E was found and bolted on to this face-plate, and set so that when the centre hole in the tool-box E ran true with the centre of the lathe, the tool-box was up against the stop F, and in this position the rest D was firmly bolted on to the face-plate; the casting was then put on to the lathe-carriage as shown, the rest-slide being taken off to allow of this being done, and a casting G being put upon the carriage to bring the centre of the casting A B in a line with the centre of the lathe. The casting G had projections cast on to fit into the casting A B, the latter being bolted on to the carriage by the bolts H and I. In order to bore the casting the tool-box was wound up against the stop F, as shown in Fig. 2, and a twist-drill being fitted into this tool-holder the work was fed by the hand-wheel J by means of a

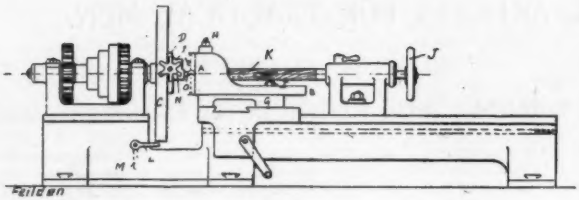

FIG. 1.

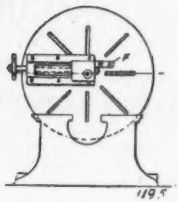

FIG. 2

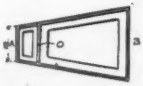

FIG. 3.

ADAPTING A LATHE FOR PLANER WORK.

block K; the catch L was lowered to the position shown at M, so that the star-wheel N would not strike it. In order to face the castings, the twist-drill was removed and the tool O inserted in its place. The tool-box E was wound towards the star-wheel N, so that it would start cutting at the corners of the casting and work towards the centre. The work was held up against the tool by means of set screws in the carriage (not shown), and by means of the block of wood K (see Fig. 1). The star-wheel N was rotated by striking the catch L and made one-sixth of a revolution for one revolution of the face-plate.

THOMAS SELLERS.

Remaking a Large Beam-Engine Cylinder-Joint.—When the cylinder of a large beam-engine commences to leak at the bottom or lower cover joint, most engineers consider it rather a serious matter to remedy, as it usually involves the lifting of several tons of dead weight before the joint can be re-made. Some little time ago a job of this description was done very simply in the following manner:—The cylinder was mounted on a square cast-iron base plate, which raised it up to the required level and also acted as the bottom cylinder cover. To carry this out, the first thing done was to take off all nuts, securing bottom cylinder flange to base-plate; then remove top cylinder cover nuts and raise this cover about a foot, packing up securely in that position. The engine was then barred round until the piston was about 8 in. from the top of cylinder or end of stroke, care being taken that the piston was on the up-stroke when the barring was discontinued. Four pieces of timber, about 6 in. square, were then cut and placed on the upper face of piston, with the grain of the timber running vertically to withstand the strain. The timber holding the cover was then removed, and the cover lowered to position and bolted on temporarily without making a joint. All was then ready for barring round the engine and breaking the bottom joint. This was done until everything felt tight; then, by driving thin steel wedges in joint between lower cylinder cover and base-plate, to assist in breaking the joint, the whole cylinder was raised by the barring gear sufficiently high to allow of joint being re-made. The joint was then cleaned and re-made, and the cylinder lowered back into position, using some brake power to prevent danger of cylinder lowering too quickly; the top cover was taken off, the packing removed, and joint made, and all nuts returned to position.

THE ATTENTION OF EMPLOYERS OF LABOUR

In our great industrial-engineering establishments is specially directed to the announcement under the heading "Workshop Practice" on page 440. Inventive capacity among workmen is much more encouraged by the masters in the United States than in Great Britain, and the result is apparent in the many new practical ideas which come quickly to the fore in that country. Those British manufacturers among our numerous subscribers and readers who will assist us in popularising this section will be rendering themselves a real service.

On the following two pages will be found the first of a series of articles which will form a sub-section to "Workshop Practice," under the heading of "Practical Articles for Practical Men." They will, as the contributions in "Workshop Practice," be contributed by practical men employed in industrial establishments.

PRACTICAL ARTICLES FOR PRACTICAL MEN.

PATTERN-MAKING AND MOULDING: THEIR POSITION IN THE ENGINEERING SHOP.

THE pattern-shop and foundry in many engineering works are departments, as a rule, that do not receive the attention they deserve, compared with the other branches of trade that make up the productive power of the workshop, although they present a very important position and a large area of industry.

In no branch of mechanical engineering are presented so many opportunities to either the student or the apprentice for the exercise of thought, as the vocation of the pattern-maker. It is in the department with which he is connected that the primary part of the machine tool, engine or other piece of mechanism, first assumes a tangible shape, and in the initial stage, presents itself to the eye of the designer in such a form that will suggest an improvement, permit of alteration or modification in design, or recommend easier means towards the machining or erecting points, which are not always apparent when the drawing is first sent into the works. Another feature of this department, is the fact that the pattern-maker is required (or, at least, should be able) to see the piece he is about to make before it has any actual existence; and it is this particular function that requires him to have a keen perception and a quick grasp of the details requisite to produce a job in the best possible manner, both from a constructive point and also to facilitate the moulding by giving proper attention to the best and easiest methods.

It is therefore imperative that the pattern-maker should have a good general knowledge of both moulding and core-making, so that he may be able to see at once what is required to produce a casting without sending the pattern into the foundry, half in doubt as to whether it is right or wrong for moulding purposes.

So much for his practical knowledge; and now to mention some other useful accessories which he should possess, but which, unfortunately, are too often neglected.

He should, in the first place, have a thorough grip of machine drawing, and a fair knowledge of arithmetic, geometry, and mensuration; as in no other part of the workshop can these subjects be more utilised, nor are such opportunities afforded for frequent and practical application.

A great many of those connected with an engineering shop assume that the finish of a pattern is dependent upon a liberal application of sandpaper and varnish, but something beyond this is required to produce a symmetrical pattern; for the pattern-maker must possess an accurate eye, so that he may detect an inequality in a curved line or the finish of a series of round corners without the aid of templets or other corrective tests. Again, it would be an error to suppose he is supplied with all the requisite information in the shape of minor details; these are left by the draughtsman to be dealt with in such a manner as may suggest themselves to the pattern-maker's ideas of an artistic finish. Another and very important subject he is called upon to study, is the behaviour of the metal in the mould, as it is necessary to take into consideration the contraction and deflection which occur in a casting during its transition from melting to cooling point; and for these changes he has to make allowance in the pattern, in order that a straight casting shall be the result; and in the allowance made, rests the test of his judgment in giving a proper amount to bring about the desired end. Now, in order to become efficient artizans, all young men who purpose going into a pattern-shop should, for at least a couple of years, become students attached to some of the many technical schools; as the pattern-maker, unlike the fitter and turner, does not have his work placed before him to operate upon, but must produce the pattern from a series of lines, to each one of which is ascribed a meaning, and sometimes indicates forms that do not always appear on the exterior, but exist in the interior; and these apparently insignificant dotted lines may represent important bosses and flanges which cannot be attached to the pattern, but have to be produced in the casting by means of core-boxes, etc., which, at times, require more study in the construction and method of making, than the actual pattern.

Nor is moulding sand the only material that is used as a matrix to produce a casting of given form; a plastic substance, technically called loam, and about the consistency of building mortar, made by the grinding together of red sand, clay, etc., is used in conjunction with bricks and cast-iron supporting plates for constructing the moulds for the larger and heavier kinds of works, such as marine cylinders, propellers, chemical pans, and heavy castings of cylindrical form; and the manipulation of this material both for cores and moulds requires the pattern-maker to detach himself from the ordinary style of pattern-making and deal with a rougher finish, though no less accurate so far as all allowances are concerned. There is a tendency in the English engineering shops to look upon the pattern-maker as a kind of necessary evil that has to be tolerated, and it is very rarely indeed he receives a modicum of praise for his efforts.

In America he is accorded a better status; and that good results are obtained may be seen by a study of the transatlantic tools and machinery which have invaded the English market during the last few years. They are altogether of a better finish in the cast-iron parts, and a deal of the attractive appearance is due to the superior finish given to the pattern and the greater attention

given to the production of smooth castings in the foundry.

The tool and machine makers in this country are too much afraid of a little extra time spent on a job in the pattern-shop, and as a consequence the men have got into a rather careless method of working, and in too many cases symmetrical appearances are sacrificed for the sake of a few hours' labour, where on the other side of the Atlantic the greatest attention is given to the smallest detail in both pattern-shop and foundry.

Another important matter, to which may be ascribed some of the shortcomings of the department, is the selection of a foreman. What qualifications should a man have to hold such a position?

First, he should be energetic, thoroughly conversant with various classes of work, well up at moulding, fully competent to give a decisive opinion as to the best method of construction, fairly quick at calculations, ready to cope with emergency jobs, of quick perception and ideas, expert in setting out work and able to discriminate between that which is necessary work and that which means superfluity and loss of time.

These acquirements must be associated with strict discipline and good morals, and with such a leader, there is no hesitancy in saying that the men under him will be inspired with a confidence that will produce a greater quantity and a better class of work. But how often do we find a man of this calibre holding a foreman's position? Seldom; and it is attributable to the fact that there is very little inducement offered to good men, the selection to fill a vacancy being too often decided on the reply to one portion of the advertisement, *i.e.*, *state wages expected.* As a good man expects a proper remuneration for his services he asks a few shillings too much, his application is ignored, the employer forgetting at the time that the best man is far away the cheapest, though his pay be a little higher.

We will now turn to the foundry and try to show how much is dependent upon that much-abused personage, the moulder. As a vocation it is perhaps the roughest and most laborious of any in the engineering trade, and at the same time it is coupled with a degree of uncertainty so far as satisfactory results are concerned, and surrounded with so many adverse influences that the best arrangements and the most studied efforts may end in disappointment, and discomfit the most skilful workman.

Let us take a glance at his usual surroundings. In the majority of foundries connected even with large firms he works in ill-ventilated, badly-lighted shops, enveloped in an atmosphere heavily charged with dust and impurities of all kinds; such conditions must naturally oppose in every way both his mental and physical development. Then take the equipment of the shops, and we find that very little consideration is given to the tackle with which the moulder is expected to turn out a good job. The principal part of the equipment, viz., the moulding-boxes, are often in a very dilapidated condition, with broken pins, bars out, fractured corners, and the lugs on the sides which should receive the pins broken off, and cross-jointed and distorted castings are the outcome of badly drilled and fitted moulding-boxes.

Again, in many of the foundries, the workman is continually losing time in hunting about for odds and ends to make up for deficient requisites, which the outlay of a few pounds would provide, and which would enable him to turn out more rapidly and with greater certainty a better class of work.

In conjunction with the moulder, and as an auxiliary in his successes and failures, is the core-maker. This individual is responsible for that portion of the mould which consist of the sand cores used in various ways in green sand moulding, thus the moulder is somewhat dependent upon the quality of the cores which are made for him.

The core-shop, as an adjunct of the foundry, is a department that, in many works, needs reform. It is, like the other portion of the foundry, badly equipped: for instance, we find what are termed standard core-boxes used for making cylindrical cores anything but cylindrical, the timber of which they are made having shrunk and twisted by the heat, through want of accommodation and a proper place to keep them when not in use. But, to revert to the moulder; let us see what is required of him, apart from his proficiency at the trade.

He should have some knowledge of the treatment of metals, should be able to judge the suitability of the sand for different jobs, must thoroughly understand the making of cores and the securing of them in the best possible manner within the interior of the mould, and for the foreman of an *up-to-date* foundry should be added the following. He should understand a *working drawing*, be fully competent and quick to suggest the best method of making a job in green sand, dry sand, or loam, and possess a good judgment as to the quantity of metal required to fill a mould, the best arrangement for running and the number of runners and position of *heads and risers* to ensure the solidity of the casting.

He should understand the management of the cupola, and direct the furnace-man as to the proper quantity or kind of pig or other metal he shall melt for any specific work. His ability to understand a drawing will recommend itself, as he can then be consulted by the pattern-maker on points where there may be a doubt as to the best method, and thus save objections made sometimes too late to be easily remedied.

In conclusion, it may be said that although the pattern-maker and the moulder do not profess to work or measure to the thousandth of an inch, still they must measure probabilities without a rule to do so, and depend solely upon their intelligence to guage them correctly.

Therefore, if we admit the premises and the responsibility attached to each department, we must accord both the pattern-shop and foundry high positions in the engineering workshop.

W. H. Wilson.

INDUSTRIAL PROGRESS

ENGINEERING NOTES AND COMMERCIAL INFORMATION

FROM ALL SOURCES.

CIVIL AND MECHANICAL ENGINEERING.

Progress of the Nile River Works.—The work on the dams being constructed on the Nile river is being rapidly proceeded with. At Assouan the Bab-el-Kebir, Bab-el-Sogair, and Bab-el-Haroun channels have been closed, and the works of these important points are being vigorously proceeded with. Two-thirds of the main wall will be practically completed this season, and the masonry of the navigation channel has been commenced. At Assiout the works are so advanced that it is hoped this dam will be completed a year earlier than the contract time. About 15,000 men are now employed; but more will be required as the season advances, thus giving employment to many natives who would otherwise greatly suffer in consequence of the lowness of the Nile causing so much land to be out of cultivation.

The Manufacture of Steel Balls.—A machine has been invented and is being brought out by a New York Syndicate for the automatic manufacture of steel balls. The machine automatically forms and polishes perfectly spherical balls at the rate of 65,000 a day. In the operation of the machine cubical pieces of steel, hot, each of which is to be made into a ball, are fed into the top of the machine, one at a time. The principal parts of the machine are a cone of steel two or three feet high and a cover of steel that fits over it. In the face of the cone is a groove that winds around it from the top to the bottom, growing smaller as it nears the bottom. On the inner surface of the cover is another groove that just matches that in the cone. The cone is kept whirling all the time, and when a piece of steel is put in at the top it is worked downward through the spiral groove, which rolls it on all sides and in all directions, and drops it out at the bottom of the machine a perfect sphere of steel. The fibres of the steel are not cut and are instead packed together more tightly than when cut from the rod into the rough pieces to be fed into the mill.

The Production of Armour-Plate.—Armour-plate is now being manufactured by four firms in this country: Messrs. John Brown & Co., Messrs. Cammell & Co., Messrs. Beardmore & Son, and Messrs. Vickers, Sons & Maxim. After the attempt recently made in the United States to establish an arbitrary Government price for its production in that country, the following particulars may be interesting. For plain armour the British Government pays as an average £83 a ton, while the United States Government pays £98 to £120 per ton. For nickel-steel armour the United States pays for the lower limit £100 a ton, the upper limit £115, and for special plates £120 to £145 a ton; while France pays £89 and £95 a ton for lower and upper limit respectively. The modern Harveyised plates cost Britain £100 to £105 a ton, the United States £110 to £127 a ton, and France £104 to £108 a ton. The difference between the French and the American prices is due in some measure to difference in percentage of nickel. In the States there is 3·25 of nickel per cent. of steel; in France from 2 to 2·5 per cent. The United States has paid a Sheffield firm £107 a ton for compound armour, but since the Bethlehem Company in Pennsylvania took their first contract, in June, 1887, the United States Government has not had to go out of the country for its armour. The principal American firms engaged in this business are the Carnegie and the Bethlehem Steel Companies.

The Spread of Municipalism.—The statement that a petition is about to be presented to the Lord Mayor of Cardiff, requesting him to convene a meeting of the ratepayers to consider the present cost of coal and the expediency of municipalising a coal-mine in the interests of the Corporation and ratepayers generally, is a significant feature. Municipalities are now directly concerned on an enormous scale with engineering enterprises of various kinds; and, generally speaking, it cannot be said in a broad sense that their results have, so far, proved unsatisfactory.

A Russian Comparison.—The American rapid mechanical filters, says a report made in Russia, require a space 40 times less than the English filters, and are characterised by their neatness, accessibility and ease of control of their operations and extreme cleanliness of all operations connected with them, and, at the same time, their first cost is considerably less. In Russia these are in demand because of their capacity for purifying the most turbid water to crystalline clearness, and freeing it from any brownish soily colours. The mechanical filters have come into extensive use in America. Scientific investigations have recently proved their capacity to remove bacteria from water to be not

less than that of the English slow filters. All these considerations give good reason to think that Russian cities which have not yet decided to instal English filters, or such as have been unsuccessful with them, will take advantage of the workings of mechanical filters as soon as examples of their use and application appear in the country.

Another "New Power."—It is stated that Prof. Elihu Thomson (who was recently credited with a revolutionary steam engine) has pending, ready for issue, a patent on what he calls the "sun furnace," which he claims is adaptable to smelting ores and generating heat far intenser than the electric furnace. Metallurgists say that it is well adapted to glass-making and manufacturing of carbide. The application made by Prof. Thomson is a wide one, and after carefully studying it at the Patent Office he has been granted a complete novelty. The invention (says the same authority) is likely to interest mining men and large smelters of ore.

A Pneumatic Gold-Digging Machine has been devised in California, and includes a barge carrying steam plant and washing apparatus. In the forward part of the barge is a well, and through this by means of guides and hoisting chains, is lowered or raised a cylindrical shaft terminating in an enlarged working chamber. This shaft and chamber is surmounted by an air-lock, and is supplied by compressed air in the ordinary way. A pipe passes from a powerful centrifugal pump, through the roof of the working chamber, to the bottom of this chamber, and is fed with gravel by a man stationed in the chamber. The pumped gravel goes to a revolving screen on the barge, and the finer material goes through 160 ft. of sluices, in which the gold is caught. To aid the man in excavating a force-pump supplies him with a powerful stream of water. The plan followed is to sink this caisson through the gravel and thus reach the bed-rock where the best gold is usually found. The device is said to be so successful that four large plants of this type are to be built at once.

Armament Difficulties in America.—A good deal was heard of the securing of the construction of the cruiser *Variag* for the Russian Government by the well-known Cramp Company, of Philadelphia. The time already taken in the building of the cruiser will be augmented in a manner to which we are not accustomed in this country, viz., the necessity of sending the 36 guns, which constitute the armament, from the Russian ordnance depôt, near St. Petersburg, to the vessel at Philadelphia to be mounted. The speed of the cruiser is to be 23 knots an hour.

The Increasing Weight of Locomotive Engines.—At a recent meeting of the Institution of Civil Engineers, attention was directed by Mr. W. B. Farr to the increasing weight of locomotives and the consequent necessity of some alteration in the present practice in designing railway underbridges in relation to the moving loads upon them. The author of the paper referred to pointed out that under existing Board of Trade rules, no allowance (save in the case of cast iron) was made for impact and other features, but that the girders were required only to be sufficiently strong to carry the heaviest locomotive, travelling crane or boiler-truck in use, calculated as a static load. The author suggested that, as the weight of the most recent and heaviest locomotives on British railways had, owing to the limitations of the loading gauge, reached its maximum, any further increase of weight having to be obtained by increased length and consequent increase in the number of wheels carrying the weight, the present was a suitable time for reconsideration of the rules, making allowance for impact and the other factors considered, and specifying the stresses permissible in the metal of the girders, using varying co-efficients or factors of safety, preferably some modification of Wöhler's law, somewhat similar to the regulations governing the construction of bridges which had been drawn up by the principal European and other Governments.

The Diesel Oil Engine.—Among new types of oil engines none has attracted so much attention, among theorists as well as practical engineers, as the Diesel engine. Its inventor has made a special study of the utilisation of heat in gas and oil engines for a period of nearly 15 years, and is known as the author of a small volume entitled "Theory and Construction of a Rational Heat Motor," in which he lays down the principles that must guide those who desire to make real improvements in the construction of engines. He started with the investigation of the cause of the relatively low heat efficiency of steam engines, even when superheated steam is used, and the well-known fact that the loss of heat in the boiler, owing to the nature of steam, amounts to from 20 to 30 per cent. As many other experimenters, he came to the conclusion that, in order to increase the efficiency, a greater range of temperature in the motor cylinder is desirable, and must be attained either by increasing the cylinder or by combustion in the cylinder itself. For this purpose he proceeded on the basis of the pure Carnot cycle, and succeeded in constructing an engine which—although, of course, not all the heat generated in it is converted into work—approaches the ideal of efficiency nearer than any other heretofore constructed. Some years ago he had laid down already the following principles as a necessary basis for attaining the desired result: (1) Production of the highest temperature, not by and during combustion, but before and independently thereof, by mechanical compression of air; (2) gradual introduction of finely divided combustible into the highly compressed and heated air, in such a manner that no increase of temperature takes place during the motor stroke, but all the heat generated is at once carried off by the expansion of the gases of combustion; (3) introduction of a large quantity of air in excess, instead of admitting

only as much air as is required to obtain proper combustion of the fuel in the cylinder. The increase of compression, upon which all scientific writers on the subject agree as the best means of improving the heat-efficiency offered many practical difficulties, and required very careful attention to details, such as valves, joints, etc., but by constant efforts the inventor succeeded in obtaining very satisfactory results. Although as fuel, according to his views, gaseous or liquid fuel or powdered coal may be used, and although he first experimented with the latter, he finally decided upon using oil, to which combustible he has since confined himself. Whatever other claimants may say, and although it is true that many experimenters have for some time been advocating the use of higher compression, and proposed to regulate the process of combustion by mechanical means, Diesel has been the first to construct a working engine on these principles in which compressions twice as great as those used in other motors have been attained. He has, moreover, succeeded in obtaining work from his engine without external lamps or flame of any kind, not even at starting, for he obtains the temperature required for combustion entirely by compression of air, and ignition is produced by the periodical ignition of a minute quantity of the oil that serves as fuel. The new motor is so promising and, as is acknowledged by the most prominent scientists of Germany, rests on so sound a theoretical basis, that the most famous engineering firms of Germany were the first to acquire the right to manufacture it, namely Messrs. Krupp, of Essen, and the Maschinen Fabrik at Augsburg, who were joined later by Subger Brothers, of Winterthur, and MM. Carel, of Ghent. In 1893 a single-cylinder 12-h.p. engine was constructed as being simpler in detail than a former compound-model, and it was decided to use petroleum as fuel. Two years were spent in devising improvements, which led in 1895 to satisfactory results, and in 1897 a 20-h.p. oil motor, in which many details of the original design were modified, was constructed. The inventor claims a theoretical heat-efficiency of 50 per cent. for his single-cylinder engine, and 70 per cent. for the compound type, which he thinks better represents his theory. Professor Schröter, of Munich, confirms Mr. Diesel's claims, and other well-known engineering experts have nothing but praise for the inventor. When it is considered that the heat-efficiency of good gas and oil engines usually varies from 15 to 25 per cent., *i.e.* that the heat losses amount to 75 and 85 per cent., while according to well-authenticated experiments from 31 to 40 per cent. of the heat actually received is converted into work in the Diesel engine, and the mechanical efficiency is 71 to 75 per cent., one cannot wonder at the great expectations that are based upon this invention, which represents by far the most economical oil motor in existence. It is true that the number of engines so far sold is not yet considerable. This, however, is due probably to the tolerably high price compared with that of other oil engines, and there is no doubt that gradually the manufacture will be considerably cheapened.

ELECTRICAL ENGINEERING.

New Electrolytic Process for obtaining Chlorine and Sodium direct from Salt.—There has recently been started at Farnworth, near Liverpool, a plant serving for obtaining chlorine and sodium by electrolysis directly from the cheapest kind of salt by a new process called the Hargreaves-Bird process, which promises entirely to supersede the Kastner-Keller process heretofore in use, as being much more simple and effective and dispensing entirely with the use of mercury, which is needed in the latter. By the new method, salt of the least expensive kind—being that of the brine pumped up from its native bed, which, delivered to the factory, costs about 3*d.* per ton, as against 6*s.* 10*d.*, the ordinary price for the rough salt utilised in other alkali works—is submitted to the electrical current and both constituents are separated absolutely pure. The apparatus used is a narrow tank constituting a cell, the walls of which are porous. Brine is pumped into this cell, and on the passage of the electrical current a solution of pure soda flows slowly down from the outside of the walls yielding directly soda crystals, while the chlorine obtained automatically on the inside is led off to be used thereafter for the production of bleaching powder, chlorate of potash, or any other chlorine compounds of industrial value. There are no by-products, and no waste occurs; for even the smoke from the boiler-fires and the surplus steam from the engine are utilised in carbonating and dissolving the soda formed. The whole process, moreover, is automatic, and no manual labour is required until the products are ready for packing and storing, or shipping. The separating-cell does not seem to be different from others of the kind, except that a peculiar diaphragm is used, this being a sheet of asbestos composition, non-porous in the usual sense of the term, but yet when forming the walls of the cell it allows molecules of sodium hydroxide to pass, but very little sodium chloride.

Silent Fans.—The greatest drawback in most types of fans in use formerly was that they were extremely noisy, and considering the circumstance that fans enter into the equipment of nearly every kind of manufacturing establishment, a fan that performs its work silently is sure to obtain a wide sale. Such a fan, it appears, has been designed by the North Moor Foundry Co., and is being manufactured as a specialty by Mr. Thomas Brierley, Primrose Bank, Oldham. They are said to produce a strong blast with less expenditure of power than that required for any fan heretofore constructed, and though being sold at a remarkably low price their finish and general workmanship are declared to be admirable. Their superiority is clearly indicated by the diameter of discharge, the number of fires blown or tons of iron melted, and the speed and comparative smallness of driving strap. Praiseworthy features in these fans are the steel spindles and long bearings on each side, and the perfect balance between the different parts. The same type is manufactured also for

exhausting, in which case they are fitted with iron suction cases; and if required they are combined with steam-engines attached, which is a useful arrangement where they have to work in isolated places intermittentl y.

Electrical Process for Annealing Armour Plates.—An extremely interesting and useful application of electricity was described by Mr. C. J. Dougherty, the superintendent of the Cramp Shipyard, at a meeting of the Engineers' Club of Philadelphia. The armour plates known as Harveyised plates are usually hardened on their surface to a depth of about ⅞ in., and this hardness is so great that the plates cannot be drilled without preparation. In order to properly mount them, they must first be locally annealed in the spots where they are to be drilled; and after many futile efforts to do this by other means the electrical method was resorted to, and has proved so successful that it is now exclusively used by that famous American shipyard. The apparatus employed resembles in principle the well-known Thomson electric welder, the ends of the secondary coils being held on the surface of the plate at the spot which is to be annealed; the secondary current consequently passes through the surface of that portion of the iron and raises it to a red heat, which draws the temper of the hardened shell. As the chilling action produced by the contiguous iron is great enough to restore the temper if the current is stopped suddenly, the current has to be reduced very gradually, for which from ten to twenty minutes are allowed. The apparatus consists of a transformer, the secondary of which is made of a very large copper casting closely surrounding the primary, and both are surrounded by iron. In one spot the secondary is slit, and the two ends terminate in the contact points. The transformer is surrounded with oil, and the terminals are kept cool by a flow of water passing through them. The ratio of transformation is 100 to 1, the primary current about 100 ampères at 300 volts, and the secondary about 10,000 ampères at 2.5 to 2.8 volts. The contact surfaces are not more than half a square inch, and the current density at these spots amounts to about 70,000 ampères per square inch. The total weight of the apparatus is about 1,000 lbs., which, when it is resting on the plate, secures a good contact. Immediately under these contacts the metal remains hard and cannot be drilled, but midway between the two contacts it is sufficiently softened for the purpose. Each transformer is furnished with an alternator, which is separately excited, and is driven by a continuous-current motor, connected with the continuous-current mains running through the shipyard. The two machines are movable, and are transported to the place where the work is to be done. The regulating of the annealing current is managed by regulating the exciting current of the alternator. Two sets of annealers have been in use at the Cramps for some time, and it was by these annealers that the plates of the *Alabama* were annealed. Lately the Harveyised plates have been superseded by Krupp plates, which are still harder, being hardened to a depth of 2 in. instead of ⅞ in. as the former; but, notwithstanding, the electrical apparatus performs its work to perfect satisfaction, and thus by the use of electricity a very important technical problem has been solved.

The Jungfrau Railway.—In the year 1893 Mr. Guyer-Zeller obtained a concession for constructing an electric railway from Little Scherdegg Station to the summit of the Jungfrau. The Scherdegg Station is 6,811 ft. above sea-level on the Wengernalp Railway. According to the plan of construction, the railway line is to be open for 1-24th of a mile, while the remainder, 6.45 miles, is to run in tunnel to the base of the peak of the mountain. At Grindelwaldblick there is a station hewn in the rock, with refreshment-room lighted and heated by electricity, with bed-rooms for visitors, and living-rooms for the staff. A branch tunnel leads to Mönchjoch, where a hotel is to be erected. The main line has a 12 per cent. descent, and finally a 25 per cent. ascent. At the terminus of the line is a vertical shaft, 241 ft. high, provided with a lift, by which visitors are taken to the summit of the mountain, 13,748 ft. above sea-level. The power for working the line is furnished by two waterfalls, which furnish an aggregate of 10,000 horse-power, and three-phase current at 7,000 volts will be used and transformed down to 500 volts. Work on the line began in 1896, and is now approaching completion.

A New Dynamometer.—A new friction dynamometer was recently exhibited by Professor W. E. Dalby at a meeting of the Physical Society. The problem is to measure a twist in a spiral spring produced by the torque to be measured. For this purpose there are two pulleys side by side upon the shaft, one of them keyed to the shaft, while the other is fastened to the end of the spring, and the lead of one pulley upon the other measures the twist. There are, moreover, two other pulleys mounted upon a slide, which are joined to the first pulleys by means of a continuous band. When the shaft is at rest the slide pulleys are touching, but any motion of the shaft produces a twist of the spring, and consequently a lead of one of the shaft pulleys on the other. In this way a separation of the slide pulleys is produced which is proportional to the lead, and, therefore, also to the torque, and thus when the constants of the dynamometer and its revolutions per second are known the power transmitted is at once given.

Graphitised Electrolytic Carbons.—In former years it was fairly generally assumed that any form of carbon raised to a high temperature would be transformed into graphite, and several experimenters aimed at the production of graphite for commercial purposes in that way. One of the pioneers in this direction was Richard Werdermann, who in 1881 took out an English patent, wherein he claimed to have obtained improvements in the manufacture of carbon and graphite, while his specifications contained claims for the

manufacture of carbon and graphite by the conversion of rods or other forms of amorphous carbon into graphite of similar form, as the result of heating to a high temperature by the passage of an electric current. Castner in the year 1893 improved upon Werdermann's process, and used the product obtained in his caustic soda process; but it seems that the manufacture under the Kastner patent has now been abandoned in consequence of the inferior quality of the article produced and the high expense of electric roasting. Since 1891, says a writer in the *Chemical Trades Journal*, Mr. E. G. Acheson, in the United States, has been working on the subject of graphite formation, in connection with the development of his carborundum inventions. The theory he deduced from his earlier experiments has since been demonstrated as the law of graphite formation, and completely changes our earlier ideas, in that it has shown that amorphous carbon is not converted into graphite carbon by heat alone, but that it is essential for the amorphous carbon to pass through a chemical cycle, which is best produced under the influence of a high temperature.

In practice (as now conducted by the Acheson Graphite Co., of Niagara Falls, New York, which company is operating under Acheson's patents) the amorphous carbon as obtained in coke is mixed with tar and some suitable metal or metallic oxide, and the mass formed into the desired shape for an anode, motor brush, or other kind of article, and, after a preliminary baking, is subjected to the highest temperature attainable in the electric furnace, and the heat prolonged for sufficient time to permit of chemical reaction between the contained metallic elements and the carbon, carbides being formed, which are immediately destroyed with the volatilisation of the metal and the liberation of the carbon in a fine graphitic form.

The success of Mr. Acheson's discovery may be seen from the fact that the Mathieson Alkali Works, Niagara Falls, the Kastner-Keller Alkali Co., Ltd., of England, and the Deutsche Solvay Werke, of Germany, all of whom operate under the Kastner patents, and who formerly made use of the electrodes as prepared under the Kastner patent, now have their goods manufactured by the Acheson Graphite Co., under Mr. Acheson's patents.

TEXTILE INDUSTRIES.

A New Cop Dyeing Machine.—Many dyers and inventors have been trying to solve the problem of dyeing weft yarns in the cop form, for it saves the cost of wrapping and reeling the yarn from the cop to the hank form, and back, after dyeing, from the hank to the cop for the shuttle, with the unavoidable waste that occurs during these operations. There are many obstacles, however, in the way of a successful solution, as, for instance, the necessity of producing right through the cop one uniform tint, and, what is still more difficult in dyeing, batch after batch of cops in one and the same shade. The *Textile Mercury*, nevertheless, in a recent issue, illustrates and describes a machine, called the Beaumont, which appears to be successful. One advantage it possesses, at all events, over other cop dyeing machines, namely, that of simplicity. It represents a large dye cistern almost hemispherical in shape, mounted on four standards. From the bottom issues a pipe which is connected with the suction end of a centrifugal pump, while the delivery end of the same pump is connected with the top of the dye cistern. When the pump is in action a rapid circulation of the liquor takes place in the small-size machine at the rate of 25 gallons per minute, a speed which greatly assists in securing uniformity of colour in the dyed cops. The latter are placed upon perforated spindles resting on a perforated plate. This machine takes 125 cops at a time, while the largest size will take 1,000 cops. Over the cops is fixed a plate, called an "antifloater," to keep the cops in position. Then the plate of cops is placed into the machine, resting on a flange; the pump is set in motion, and the liquor is drawn through the cops in a steady, but rapid, current, giving them a uniform colour. With ordinary direct dyes from six to ten minutes' suffice for this purpose, and while one plate of cops is being dyed another can be prepared. By means of a jet of steam, which is sent into the machine in such a way as to avoid direct impingement on the cops, the bath may be maintained at any temperature desired. With all ordinary direct colours a temperature of 166 degrees to 170 degrees Fahr. is quite sufficient, and the machine may be used open; but for dyes which must be used at boiling heat a cover is provided, and then the work is carried on at the normal pressure of 10 lbs. There are two gauges, one of which registers the pressure when the cistern is covered, being in communication with the top of the machine; the other, being connected with the bottom portion, registers the vacuum under the cop plate attained by the working of the pump, which is usually about 5 inches. According to experts who have seen the machine in action, it performs its work properly and to the fullest satisfaction. Another detail worth mentioning is that connected with the delivery pipe of the pump is a three-way tap, so that the dye liquor may be sent either into the machine back again or into a storage tank, when it can be strengthened up for further use. Moreover, the machine may be used for bleaching as well as dyeing cops, and cotton, hemp, silk, and woollen bobbins may be dyed in it with equally good results.

The Perham Loom.—A novel loom, known as the "Perham" loom, is described in the *Lowell Textile School Journal*, from which the following details are gathered. The Perham single-shaft woollen loom, with shuttle throw of 138 inches, runs 165 picks per minute with warps of poor quality, but on print cloth it will run 350 picks per minute. One of the devices used by Mr. Perham is an improved shuttle-box, "by means of which the shuttle is gripped by a binder having a wooden guide-piece, the grip being graduated to fit the requirements of the case, as

the shuttle enters the box, and being finally released entirely just in time to allow the picker-stick to send the shuttle back with a velocity that would snap the ordinary picker were the resistance such as is given by the common binder. The mechanism by which this is accomplished is very simple. It does away with the breaking of shuttles, pickers, and weft. The shuttle flies back and forth with the utmost ease, and is not crushed or worn. The box guides the shuttle, and leaves no room for wobbling. It is assisted in stopping the shuttle by a check-strap at the foot of the picker-stick, so arranged that there is a further safeguard against damage to the shuttle, picker, or weft. In connection with the warp-beam there is a let-off motion, devised by Mr. Perham, whereby the variation of tension in the threads causes a band-brake on the beam to regulate the let-off automatically. The tension of the warp is thus kept uniform throughout the process of weaving. The cloth rollers are of perforated steel. A further interesting device is the pick-out detector. This consists of a series of light loops of wire along a light bar. As the threads of the warp go up to the harness they pass under these sensitive loops, and any snarl in the thread will cause the detector to fly out and release the power, stopping the loom instantly. The fact that there is so little machinery turning, owing to the single shaft, makes the sudden stop easy and free from jar, this result being assisted also by a very ingenious arrangement of the driving-pulley. The breaks in the weft are cared for by the 'weft-fork,' which is kept stationary instead of oscillating. It was found that the oscillator did not work well at the high speed of these looms. A long bar passing under the lay, to which it is trussed at the centre, can be tightened by nuts at the ends, enabling the operator to take up any sagging of the lay without difficulty. One of the notable features of the loom is the fact that sudden variations of speed do not affect it at all. The loom is far past the experimental stage. It has been proved to be practical, and works without any of the disadvantages which have heretofore stood in the way of great speed."

An Ingenious Loom.—A problem in weaving, to the solution of which many inventors have devoted their ingenuity, is the automatic supply of weft while the loom is running. It was first solved in a practical manner by the construction of the now well-known Northrop loom which, though little used in the country, has met with considerable success in the United States. The principle underlying this loom is the provision at one side of the breast-beam of an intermittently revolving magazine carrying a number of cops which, by a skilfully constructed mechanism, are each transferred as and when required to the shuttle, when the weft in the latter has given out, without any stoppage of the loom being caused. Since the Northrop loom became known, numerous inventions have been made dealing with the supply of cops, though most of them are characterised by the supply of shutters containing cops; but, on the whole, none of these inventions seems to have obtained any notable success. Since then, however, a loom has been designed, entirely differing from those alluded to, but containing the promise of great usefulness. This is the "Seaton Loom,' illustrated and described recently in the *Textile Recorder*, and represents an American invention which, no doubt, will be further improved in this country. The Seaton loom contains no shuttle such as we usually see, but instead a carrier is employed for traversing the weft across the shed. It obtains its weft supply from a large bobbin placed at each side of the loom, each of these bobbins being from 15 to 16 in. high, so that a large reservoir of weft is in store, and as the construction of the loom renders a break-down unlikely, and supposing yarn of a reasonable quality to be used, the loom will run practically without interruption. The bobbins remain in fixed position, and the weft is reeled off at each pick. The carrier which replaces the shuttle is of thin steel, a little longer than an ordinary shuttle, and about ½ in. thick by 1¼ in. wide. At each end it is provided with a pair of grippers, and is picked by the picking arms engaging with projections formed on its underside. There are two motions at each side of the loom for operating the carrier, one motion driving it to its box with the exception of about an inch, and the other completing the traverse by pulling it to the far end of the box. During the latter motion the jaws of the outer end of the carrier are opened so that they may embrace the weft, which at this time is approached by it, prior to the carrier being picked up again. The weft is led upward from the bobbins through a guide eye attached to the base of the bobbin, and then passes through a small tube provided at its entrance with a tension and clearer device, whence it is led through an ingenious measuring arrangement, by which the exact length of the weft required to form double the width of the piece, *i.e.* two picks, is paid out. The end of the weft is always led by its supply mechanism in such a way that the grippers of the carrier never fail to grip it when moving out to the box. On completion of the measurement the weft is cut off by a small pair of shears near the tube alluded to, and the whole arrangement is such that the cut ends of the weft are protected by the loop formed on bending the weft round the angle of the shed, so that there are no raw ends of weft showing. All these operations are performed by a neat, compact, and ingeniously designed mechanism at each side of the loom.

A similar loom has been designed by the inventor for weaving fancy goods, which, as well as the one described, contains great promise. It represents a remarkably ingenious piece of mechanism, the usefulness of which is undeniable, and will, no doubt, be still improved in the future.

RAILWAY WORK.

Success of American Locomotives.— Although, according to a report received through the Foreign Office, the United States and Canadian

locomotives constructed at present are not distinguished by speed, elegance or perfection of finish, but rather by size, weight, and power, the demand for them continues. The Baldwin Works are turning out locomotives at the rate of 1000 a year, *i.e.*, 28 per cent. more than the combined production of the four greatest English locomotive firms, *i.e.*, Neilson, 300; Dubs, 150; Sharp Stewart, 140; and Kitson, 130. If one inquires into the causes of this remarkable success and of the rapid and inexpensive production of the Baldwin works, it is evident that one of the prominent causes is the uninterrupted day and night work, combined with the piece-work system and the existence of fixed types and templates. By working day and night, double the amount of work is obtained out of the same plant and buildings, *i.e.*, the invested capital, and a very considerable saving in money and time is due to the absence of the necessity of scheming or making drawings and the fact that sets of templates and patterns are ready at hand. In addition to this the makers can employ labour-saving automatic machines constructed for the manufacture of the standard types and parts of the machinery which it is impossible to use in English workshops, where the types demanded constantly vary. How greatly these facts aid production is shown from the circumstance that the number of locomotives turned out in the United States annually increases. During the year 1899 it amounted to 2,473, *i.e.*, 598 more than in the previous year.

Eight-wheel Locomotives.—The Chicago and Alton Railroad in the United States has recently been supplied with twelve eight-wheel locomotives for fast passenger service. The total weight of these engines in working amounts to 139,000 lbs., with 90,500 lbs. on the driving wheels, the latter being 73 in. in diameter, while the cylinders are 19 in. by 26 in. These cylinders are provided with 10 in. piston valves, having a travel of 6½ in. The boilers are of the radial stay wagon top type designed to carry 210 lbs. steam pressure. The fire-box is above the frames, and has 177 sq. ft. of heating surface, while the heating surface in the tubes amounts to 2,000 sq. ft., the tubes being 12 ft. 7⅛ in. long, making a total heating surface of 2,177 sq. ft. The grate area is 31·8 sq. ft. The tender, loaded, weighs 120,000 lbs., having a capacity for 6,000 gallons of water and 12 tons of coal.

Economy of Heating Feedwater for Locomotives.—The question—"Is it economy to use exhaust steam from the air-pump to heat the feedwater?"—has been recently submitted to a committee by the American Travelling Engineers' Association and answered affirmatively by the latter. A saving of heat and fuel can, as experience has shown, says the report, be effected by utilising this exhaust even when taking into consideration the cost of the pipes, fittings, and flexible connections, and the maintenance of them necessary to conduct the steam from the air-pump to the tank. This is proved by the fact that when doing so there is an absence of the action of the exhaust on the fire when recharging the train at stations, and unnecessary blasts on the fire are expensive owing to the waste on the safety valve. It is further proved by the number of heat units saved by raising the temperature of the water in the tank a certain number of degrees without additional expense other than the cost of the apparatus required for conducting the steam to the tank. Taking water at 50 degrees temperature and raising it to 90 degrees with steam that would otherwise be lost amounts, under favourable conditions, to a saving of 148 lbs. of coal to each tank of water used, which is equal to a saving for the average locomotive of nine tons of coal per month.

MISCELLANEOUS.

Ventilation of the St. Gothard Tunnel.—The difference of the air-pressure in the two ends of the famous double-line tunnel across the St. Gothard mountain, which has a length of 9½ miles, and the resulting through current of air was, up to the year 1890, sufficient to keep the atmosphere pure enough for platelayers to work without discomfort, but since then the traffic has so much increased and consequently the number of trains running, that it became necessary to devise means for artificial ventilation, and in 1899 a complete plant based on Saccardo's system was installed to obtain this object This plant, which is situated at the north end of the tunnel, consists of a locomotive driving two fans, each five metres (16·4) in diameter. These fans serve for compressing air into a chamber surrounding the face of the tunnel, whence it issues through an annular aperture, and in a southerly direction along the tunnel, dragging the mass of air in the body of the tunnel along with it, on the principle of a steam injector. Ever since the operation of this plant was inaugurated, the air in the tunnel has been pure and free from smoky odour, and besides rendering the work of the platelayers and the personnel of inspection comfortable, it is believed that the constantly fresh supply of air will secure a longer life to the permanent way. The cost of the installation, exclusive of the locomotive, amounted to about £7,200.

S.S. "Thomas Leigh."—The official trial of this vessel, built by Messrs. Ritson & Co., Maryport, for Messrs. R. Craggs & Sons, Middlesbrough, was concluded on the 1st March at Swansea, the vessel leaving the Mumbles in the morning to run speed and consumption trials. The vessel is 190 b.p. × 29 ft. 10½ in. moulded breadth × 15 ft. 1 in. depth, and has a dead weight carrying capacity of 1,100 tons. She is owned on the Continent, and was built under Germanischer Lloyds special survey, and to German law requirements. The machinery department was supplied by Messrs. McKie & Baxter, Copland Works, Govan, and consists of a set of triple expansion engines, 15½ in., 25 in., and 41 in. × 27 in., supplied by steam at 170 lbs. working pressure from a boiler 13 ft. 6 in. × 10 ft.

long. The donkey boiler is by Messrs. Cochrane, of Birkenhead, and evaporator and filter is supplied by Messrs. Henry Watson & Sons, Newcastle-on-Tyne. Electric light is fitted for the rapid loading and discharging of cargo, and throughout the vessel is fitted with all the latest modern appliances found in an up-to-date cargo boat. Mr. Moller represented the owners and surveying societies, and the builders and engineers were also represented. The speed and consumption trials were well within the contract, and the trial a most satisfactory one.

Errata.—On p. 304 we inadvertently described Mr. J. T. Middleton, the managing partner of Messrs. Walter Scott & Co., Westminster, as the head-agent of that firm. In the article on "Armour Plate v. Projectile," for *Sir* R. A. Hadfield, read *Mr.* R. A. Hadfield.

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In this section is presented every month a concise précis of the contents of the leading organs of the technical press and of the proceedings of learned societies throughout Great Britain, the Continent, and America, and also, in a summarized form, the subject matter of the more important articles appearing therein.

This systematic record should prove of the greatest value to those of our readers interested in one or more specific sections of technology, trade or economics, or to those who have insufficient leisure to peruse the large number of publications now appearing.

The following is an Index to the abbreviations used throughout the section. It gives an alphabetically-arranged list of the publications regularly reviewed, together with the place of publication and price. Should any of our readers desire further information we shall be happy to supply it.

Advertisers' Review	London	1*d.*	*Ad. Rev.*
American Machinery	New York	10*c.*	*Am. Machy.*
American Machinist	New York	6*c.*	*Am. Mach.*
American Manufacturer & Iron World	Pittsburg	8*s.* yr.	*Am. Mfgr. and Ir. Wld.*
American Shipbuilder	New York	10*c.*	*Am. Shipbldr.*
Annales des Ponts et Chaussées	Paris		*Ann. des Pts. et Chauss.*
Architect	London		*Archt.*
Architectural Record	New York		*Arch. Rcd.*
Architectural Review	Boston U.S.A.	1*s.*	*Arch. Rev.*
Arms & Explosives	London	6*d.*	*Arms and Exp.*
Australian Mining Standard	Sydney	6*d.*	*Aust. Min. Stand.*
Australian Trading World	London	2*d.*	*Aust. Trdg. Wld.*
Automotor and Horseless Vehicle Journal	London	6*d.*	*Autom. and Horsel. Veh. Journ.*
Berg und Hüttenmannische Zeitung	Berlin		*Berg Hüttenm. Ztg.*
Board of Trade Journal	London		*Board of Tr. Journ.*
Book & News Trade Gazette	London	1*d.*	*Bk. and Nws. Trd. Gaz.*
British Architect...	London	4*d.*	*Brit. Archt.*
British & Colonial Druggist	London	10*s.* yr.	*Br. and Col. Drgst.*
British & Colonial Printer	London	2*d.*	*Bri. and Col. Prtr.*
British Printer ...	Leicester	1*s.*	*Br. Prtr.*
Builder	London	4*d.*	*Bldr.*
Bulletin de la Société d'Encouragement	Paris		*Bull. d. l. Soc. d'Encour.*
Canadian Architect	Toronto		*Canad. Archt.*
Canadian Electrical News	Toronto		*Canad. Elec. News*
Canadian Engineer	Montreal		*Canad. Engr.*
Canadian Manufacturer	Toronto	8*s.* yr.	*Can. Mfgr.*
Canadian Mining Review	Ottawa		*Canad. Min. Rev.*
Carriage Builders' Journal	London	10*s.* yr.	*Carr. Bldr's. Journ.*
Chamber of Commerce Journal	London	1*s.*	*Chamb. of Com. Journ.*
Chemical Trades Journal	Manchester	4*d.*	*Chem. Trds, Journ.*
Coach Builders' Art Journal	London	25*s.* yr.	*Coachbldr's Art Journ.*
Cold Storage ...	London	6*d.*	*Cold Storage*
Colliery Guardian	London	6*d.*	*Coll. Guard.*
Commerce... ...	London	6*d.*	*Comm.*
Comptes Rendus de l'Acad. des Sciences	Paris		*Compt. Rend.*
Contract Journal	London	6*d.*	*Contr. Journ.*
Deutsche Techniker Zeitung	Berlin	9 *mk.* 25 *pf.* yr.	*Deutsch. Techn. Ztg.*
Dingler's Polytechnisches Journal	Stuttgart		*Dingler's Polyt. Journ.*
Diplomatic & Consular Reports	London & Washington		*Dipl. and Cons. Rpts.*
Echo des Mines ...	Paris & Brussels	40 *fr.* yr.	*Ech. d. Mines*
Eclairage Electrique	Paris		*Ecl. Elect.*
Electrical Engineer	London	3*d.*	*Elec. Engr.*
Electrical Engineering	Chicago		*Elec. Engrg.*
Electrical Review	London	4*d.*	*Elec. Rev.*, London
Electrical Review	New York	10*c.*	*Elec. Rev.*, New York
Electrical World...	New York	10*c.*	*Elec. Wld.*
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Engineer	Cleveland U.S.A.	5*c.*	*Engr.*, Cleveland
Engineering ...	London	6*d.*	*Engrg.*
Engineering and Mining Journal	New York	15*c.*	*Engrg. and Min. Jour.*
Engineering Magazine	New York & London	1*s.*	*Engrg. Mag.*
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Engineering Record	New York	12c.	*Engrg. Rcd.*
English & Amer. Gazette	Paris	20c.	*Engl. and Am. Gaz.*
English Mechanic	London & New York	2d.	*Engl. Mech.*
Gas Engineers' Magazine	Birmingham	6d.	*Gas Engrs' Mag.*
Gas World	London	6d.	*Gas Wld.*
Gaz, Le	aris	1 *fr.*	*Gaz*
Génie Civil	Paris		*Gén. Civ.*
Gesundheits-Ingenieur	Munchen		*Ges. Ing.*
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Hardware, Metals & Machinery	London	5*s.* yr.	*Hrdw., Mets. and Machy.*
Hardware Trades Journal	London	6d.	*Hrdw. Trds. Journ.*
Heating & Ventilating	New York		*Heatng. and Vening.*
Ice & Cold Storage	London	6d.	*Ice and Cld. Storge.*
Illustrated Official Journal of Patents	London	6d.	*Ill. Off. Journ. of Pat.*
Indian & Eastern Engineer	Calcutta	R1.	*Ind. and East Engr.*
IndianEngineering	Calcutta		*Ind. Engrg.*
Industrie Electro Chimique	Paris	60c.	*Ind. Elec. Chim.*
Industries & Iron...	London	4d.	*Ind. and Ir.*
Invention	London	1d.	*Inv.*
Irish Textile Journal	Belfast	11*s.*6d. yr.	
Iron Age	New York		*Ir. Age.*
Iron and Coal Trades Review	London	6d.	*Ir. and Coal Trds. Review*
Iron & Steel Trades Journal	London	3d.	*Ir. and Steel Trds. Journ.*
Ironmonger ...	London	6d.	*Ironmgr.*
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Machinery	New York		*Machinery*, New York.
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Mining World ...	London	6d.	*Ming. Wld.*
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Modern Machinery	Chicago	$1	*Mod. Machy.*
Mois Scientifique	Paris	$1.50	*Mois Scient.*
National Laundry Journal	Chicago	15c.	*Nat. Ldry. Journ.*
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Nature	Paris		*Nature*, Paris
Nautical Gazette ...	New York	10c.	*Naut. Gaz.*
Oest. Monatsschr. f. d. Oeff. Baudienst	Vienna		*Oest. Monatsschr. f. d. Oeff. Baudienst*
Oest. Zeitschr. f. Berg und Hüttenwesen	Vienna		*Oest. Zeitschr. f. Berg u. Hüttenwesen*
Paper & Pulp ...	London	6d.	*Pap. and Plp.*
Power	New York	10c.	*Power*
Practical Engineer	London	2d.	*Pract. Engr.*
Public Health Engineer	London	3d.	*Pub. Hlth. Engr.*
Railway Engineer	London	1*s.*	*Rail. Engr.*
Railway & Engineering Review	Chicago	$5	*Rail. and Engng. Rev.*
Railway Magazine	London	6d.	*Rail. Mag.*
Railway Master Mechanic	Chicago	$1.50	*Railw. Mast. Mech.*
Railway News	London	6d.	*Rail. News*
Railway Official Gazette	London	1d.	*Rail. Off. Gaz.*
Railway Record ...	London	6d.	*Rail. Rcd.*
Railway World ...	London		*Railw. Wrld.*
Revista Minera ...	Madrid	25 *fr.*	*Rev. Min.*
Revue de Chimie Industrielle ...	Paris	15 *fr.*	*Rev. d. Chim. Ind.*
Science Abstracts	London & New York	2*s.*	*Science Abstr.*
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Scientific American Supplement	New York	$5 yr.	*Sci. Am. Suppl.*
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World's Pulp & Paper Industry	London	6d.	*Wld's. Pulp and Ppr. Ind.*
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Zeitschr. d. Ver. Deutscher Ingen.	Berlin		*Ztschrft. d. Ver. Deutsch. Ing.*
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Zeitschrift für Elektrotechnik	Halle a. S.		*Ztschrft. Elektrotech.*

ARCHITECTURE AND BUILDING.

1. Construction and Design.

Underpinning.—*Underpinning Shop Walls.* The Pennsylvania Avenue Subway in Philadelphia, Pa., U.S.A., built to carry four tracks of the Philadelphia and Reading Railway below street grade consists, between Sixteenth and Twenty-second streets, of an open cut nearly in the middle of the Avenue, 80 ft. wide and 24 ft. deep. It was built through a manufacturing district where, in some places, heavy shop buildings extended to the building lines of the street. To avoid any danger of settlement near the subway the first step was to provide for the stability of the buildings. Some of the most interesting work done for this purpose was the underpinning of the two-story brick shops of William Sellers & Co., described in this article. (Ill.). 2 cols.—*Engng. Rcd.*, Jan. 13th, 1900.

Tabernacle.—*The Mormon Tabernacle, Salt Lake City, Utah.* By W. P. Hardesty, C.E. Description of the present Tabernacle which replaces the old one which stood near it. It was commenced in July, 1864, and completed and dedicated Oct. 6th, 1867. (Ill.) 4½ cols.—*Engng. Rcd.*, Jan. 27th, 1900.

2. Heating, Ventilation and Sanitation.

3. Plumbing and Gasfitting.

4. Miscellaneous.

Cement.—*Tests of the Constancy of Volume of Portland Cement.* II. The article deals with the conclusions drawn by Mr. Max Gaez from the results of experiments for determining the constancy of volume (soundness) of Portland Cement conducted at the Royal Mechanical Testing Laboratory at Charlottenburg, Prussia. 6½ cols.—*Engng. Rcd.*, Jan. 27th, 1900.

CIVIL ENGINEERING.

1. Bridges.

Bridges.—*The New Tugela Bridge.* Note mentioning that a world's record for bridge-building has been made by the Patent Shaft & Axletree Co., Ltd., Wednesbury. The Company pledged itself that the Tugela bridge should be executed—not from stock designs as is the American fashion, but to any design the Government might decide upon—in the short space of six weeks. In three weeks, or half the time allowed under the contract, the bridge was ready, and at the end of the allotted time will probably be well on its way to Africa. ¾ col.—*Commercial Intelligence*, Jan. 27th, 1900.

—— *The New Colenso and Frere Bridges.* The article is accompanied by a detailed drawing of the first span, and gives the essential data of the bridge constructed by the Patent Shaft and Axletree Company. ¾ col.—*Engr.*, Feb. 16th, 1900.

—— *Some Light Highway Suspension Bridges.* Account of bridges recently built by the John A. Roebling's Sons Co., New York, applicable to difficult highways in mountain districts, when regular trussed structures would be too expensive and untrussed cables can be employed. 5 cols.—*Engng. Rcd.*, Feb. 3rd, 1900.

—— *Economies in Railway Bridge Design and Manufacture.* By J. Graham, M. Inst. C.E., Bridge Engineer, G. I. P. Ry., India. The author treats the subject mainly in relation to bridges for export, in the providing of which there is the liability of competition from outside sources. 2½ cols.—*Engr.*, Jan. 26th, 1900.

2. Canals, Rivers, and Harbours.

Canals.—*The Rhine-Elbe Canal and German Industries.* Outline of the schemes of the German Government for improving the canal transportation of the Zollverein. In addition to the Dortmund-Ems Canal, opened by the Emperor a few months ago, there is now a project for a through water transport from the Rhine to the Elbe, of which the article gives the details set forth in a bill laid before the Prussian Parliament. 2½ cols.—*Ir. and Coal Trade Rev.*, Feb. 9th, 1900.

Canals.—*The New York Canals.* Summary of a report drawn up by Major Thomas W. Symons, Corps of Engineers, U.S.A., Mr. Edward A. Bond, State Engineer and Surveyor, Mr. John N. Partridge, Superintendent of Public Works, A.O., on the condition of the State canals, and the proper policy to be followed concerning them. 8½ cols.—*Engng. Rcd.*, Feb. 3rd, 1900.

Dredging.—*Dredge Plant by Wm. Simons & Co., Ltd., Renfrew.* Description of various types of dredgers, traversing bucket-ladder dredges, dredgers of the bowwell ladder type, barge-loading dredgers, twin-screw hopper grab dredgers, &c. (Ill.) 2½ cols.—*The Steamship*, Feb., 1900.

Lake Regulation.—*Report of the Deep Waterways Board on the Regulation of the Great Lakes.* The report deals with a project for establishing and controlling by artificial means the water-levels of Lakes Erie, Huron and Michigan, covering 60 000 square miles, with their connecting waterways. The realisation of such a project would be the most stupendous physical effort ever produced by man's agency; but it is seriously proposed to accomplish this task, and detailed plans have been prepared and a bill has been introduced in Congress which provides that it shall be undertaken by the United States Government. The scheme is advocated by the Government Board of Engineers on Deep Waterways, and described fully in the present report. (Ill.). 3 cols.—*Engng. News*, Jan. 4th, 1900.

Weir.—*The Lake Erie Regulating Weir.* Account of a report explaining the project recently sent to the Secretary of War by the Deep Waterways Commission. (Ill.). 4½ cols.—*Engng. Rev.*, Jan. 6th, 1900.

Locks.—*The Lift Lock near Heinrichenburg, Germany.* Description of one of the most prominent features of the Dortmund-Ems Canal, namely, the lock that connects the Dortmund and Herne levels. (Ill.) 2¼ cols. *Engng. Rcd.*, Jan. 13th, 1900.

3. Irrigation.

Irrigation.—*Irrigation in the Jeypore States.* The article begins with an extract of a descriptive sketch written by Rudyard Kipling, who, as a newspaper reporter, visited Jeypore, and admired the engineering works of Colonel Jacob. The author then proceeds to describe a number of irrigation works constructed by Colonel Jacob, of which an account was recently given by Mr. Charles E. Stotherd in a paper presented to the Institution of Civil Engineers. 3 cols.—*Engng. Recd.*, Jan. 13th, 1900.

4. Miscellaneous.

Drainage.—*Erection of Drainage Plant.* Description of a drainage plant at Port Mourant, Berbice, British Guiana, consisting of a Tangye's coupled compound condensing Belfast centrifugal pumping engine, capable of delivering 300 tons of water per minute with a total lift of 5 ft., working with a steam pressure of 150 lbs. per square inch. The engine by the same makers is coupled compound condensing, with high-pressure cylinder 13 in. in diameter, and 25 in. low-pressure cylinder with 24 in. stroke, coupled direct to the centrifugal pump, and running at 99 revolutions per minute. The description refers to all important details of the installation and the work accomplished. (Ill.). 2 cols.—*Engr.*, Jan. 3rd, 1900.

ELECTRICAL ENGINEERING.

1. Electro-Chemistry.

Electro-Chemistry.—*Manufacture of Calcium Carbide at the Works at Saint Marcel d'Aoste.* Reproduction of an article in "l'Eclairage Elec-

trique" on the subject, summarising a communication by M. Segrée. 4½ cols.—*Ind. Elec.-Chim.*, Dec. 1899.

Electro-Chemistry.—*Preparation of Arsenetted Strontium, Barium, and Lithium in an Electric Furnace.* The article deals with the preparation of $As^2 Sr^3$, $As^2 Ba^3$, and $As Li^3$ by the reduction of the arseniates of strontium, barium, and lithium by means of carbon heated in the electrical furnace. 4 cols.—*Ind. Elec.-Chim.*, Nov. 1899.

—— *Stassano Process.* Description of an interesting process lately devised by an Italian engin er, Stassano, for the production of iron and steel by the electric furnace, using the heat of the arc to reduce the oxides and fuse the resulting metallic mass. (Ill.). 1½ col.—*Sci. Am.*, Feb. 10th, 1900.

—— *The Chemical Constitution of an Ammoniacal Solution.* By D. Tommasi. The author deals with the question whether an aqueous solution of ammonia containing $Az H^4$, O H is analogous to the hydrate of potassium K H O and the hydrate of sodium Na O H. Many chemists hold that it contains hydrate of ammonia, but the author demonstrates that hydrate of ammonia does not exist in this solution, and that it is wrong, therefore, to compare it with a solution of potassium or sodium. 1½ col.—*Ind. Elec.-Chim.*, Nov. 1899.

—— *Electrolysis of Water by the Garuti Process*, in which, by means of a metallic diaphragm, the separation of the hydrogen from the oxygen is obtained without augmenting the electric resistance of the apparatus. 3 cols.—*Ind. Elec.-Chim.*, Nov. 1899.

Electrolysis.—*Electro-Deposition of Chromium.* Description of a method of depositing chromium from aqueous solutions patented by Placet Barnet, which can be used on a commercial scale. 1 col.—*Chem. Trades Journ.*, Feb. 3rd, 1900.

Electrolytical Applications.—*An Electrolytic Centrifugal Process for the Production of Copper Tubes.* By Sherard Cowper-Coles. Abstract of a paper read before the Institution of Electrical Engineers, Jan. 25th, 1899. (To be continued.) 7 cols.—*Mech. Engr.*, Feb. 10th, 1900.

Galvanizing.—*Electro-Galvanizing.* By Sherard Cowper-Coles. The author describes in a practical way the most suitable method of electro-zincing such as is used in the Normand, Thorneycroft, and Belleville boilers, or in the coating of plate and angle irons of torpedo-boat destroyers. (Ill.). 2 cols.—*Ind. and Iron*, Feb. 2nd, 1900.

2. Electric Lighting.

Electric Light.—*The Electric Light Installation on the ss. Oceanic.* The electrical installation put up by Messrs. W. H. Allen, Son and Co., of Bedford, consists of four generating units. The engines of compound twin type are direct-driving, and the dynamos give an output of 100 volts 600 ampères at a speed of 240 revolutions per minute. The total number of lamps installed is 1,975, of which 350 are fixed in the engine and boiler rooms, whilst the motors, heaters, and other apparatus demand current approximately equal to that taken by the lamps. 2½ cols.—*The Steamship*, Feb. 1900.

—— *Alternating-Current Arc Lighting.* By E. P Warner.—Abstract of a paper read before the Chicago Electrical Association, giving a short history of alternating-current lighting, and pointing out its advantages, disadvantages, and prospects. 9 cols.—*Elec. Rev.* (New York), Jan. 31st, 1900.

3. Power.

Continuous Current Transmission.—*Electrical Transmission of Continuous Current, System Thurz.* Abstract of a paper by M. H. Cuénot, read in January before the "Société Internationale des Electriciens" at Paris, describing the Thurz system. In this system the power station is equipped with continuous current dynamos which furnish a current of constant strength, and of which a certain number, depending on the e. m. f. demanded by the motors, is connected in series. The motors which spread over the whole line of transmission are also connected in series. 2 cols.—*Electrotechniker*, Feb. 15th, 1900.

Dynamos.—*Arnold Magnetic Clutch.* It is often desirable to arrange generators in such a way that they may be readily connected and disconnected to the prime mover. This requirement has been met by Mr. Bion J. Arnold, who has designed a magnetic clutch, here described. (Ill.). 1 col. *Elec. World and Engr.*, Feb. 3rd, 1900.

Electrical Distribution.—*Alternating Current Distribution.* Summary of the action brought by Rucker *v.* the London Electric Supply Corporation, in which judgment was given for the defendants. 2½ cols.—*Engr.*, Feb. 16th, 1900.

Electrical Driving.—*Electrical Driving by means of tooth-wheel transmission.* By O. Lasche, Berlin. The author deals with the precautions to be taken in order to obtain by tooth-wheels a regular and uniform rotation. (Ill.). 3½ cols.—*Stahl u. Eisen*, Feb. 1st, 1900.

Electric Generators.—*An Improved Electro-Magnetic Apparatus.* Description of an efficient type of electro-magnetic machine, invented by Francisco de Borja Pavon, of Caibarien, Cuba and constructed on a principle that can be applied to bi-polar machines or to multi-polar machines with a double circuit. ¾ col. *Sci. Am.*, Feb. 10th, 1900.

Electrical Generators.—*The Design of Monophase and Polyphase Generators.* By B. A. Behrend. The article gives some experimental results valuable for making comparisons with machines of American design. 5 cols.—*Elec. World and Engr.*, Jan. 27th, 1900.

Electrical Plant.—*The Standardisation of Electrical Engineering Plant.* By R. Percy Sellon. The author recommends the general acceptance, to a far greater extent than at present, of certain standards of output, quality, efficiency, or other characteristic of electrical plant. 4½ cols.—*Ind. and Iron*, Feb. 9th, 1900.

—— *Iron Works operated by Niagara Electric Power.* Description of another application of the Niagara power at Buffalo, N.Y., *i.e.* of the electric equipment of the steel and malleable iron plant of Pratt's Letchworth, at Black Rock, which covers 12 acres under roof, besides 11 acres of yard space. Of chief interest are two electric cranes which carry the molten metal to the various moulds. The motors of these cranes are direct-current 220 vol. motors and receive their current from rotary transformers. (Ill.). 1½ col. *Elec. World and Engr.*, Feb. 3rd, 1900.

—— *The Designing of Electric Generating Stations.* Abstract of a paper by A. Roberts, M.A., read before the Society of Architects, describing the selection of site, location of coal stores, equipment of boiler-house, engine-house, workshops, etc. 5 cols.—*Elec. Engr.*, Feb. 2nd, 1900.

—— *Plant of London Metropolitan Electric Supply Company.* Description of the plant which was laid down two years ago by the English Westinghouse Company for supplying three two-phase alternators of 2,500 h.-p. each, which was then an innovation in lighting practice, exceeding anything constructed up to that time, excepting the 5,000 h.-p. generators at Niagara Falls. (Ill.). 2½ cols.—*Elec. World and Engr.*, Feb. 3rd, 1900.

—— *Electrical Equipment of United States Government Powder Factories.* The article describes an equipment composed of polyphase generators built by the Westinghouse Electric and Manufacturing Company, for the Indian Head Powder Factory on the Potomac, near Washington, D. C. (Ill.) 2½ cols.—*Engng.*, Jan. 26th, 1900.

—— *New Electric Plant at Cambridge.* Description of a plant recently constructed by the

Cambridge Electric Supply Company. ¾ col.—*Engr.*, Jan. 12th, 1900.

Motors.—*The Polyphase Induction Motor. I.* By Ralph D. Mershon. A paper read before the North-Western Electrical Association at Milwaukee, Wis., U.S.A. The author correlates the action of the induction motor with that which occurs in the direct-current motor, and lays much stress on the analogy between the direct-current shunt motor and the induction motor. 5½ cols.—*Elec. World and Engr.*, Feb. 3rd, 1900.

—— *The Application of Electric Motors to Printing Presses. IV.* Article describing various motors manufactured by the British Thomson-Houston Company, and used in printing offices. (Ill.) 4½ cols.—*Brit. and Col. Print. and Stationer.*

—— *New Experiments regarding the Calculation of Friction in Bearings.* By G. Dettmar, Chief Engineer in Hanover. Reproduction of an article published in the *Elektrotechnische Zeitschrift*, 1899, pp. 203, 380. 12½ cols. *Dingler's Polyt. Journ.*, Feb. 10th, 1900.

—— *Alternating Current-Power Motors.* By W. A. Layman. (Conclusion.) Article describing the results obtained by a test made by students of the University of Nebraska during the spring of 1898, upon a 5 h.p. motor, under the direct supervision of Professor R. B. Owens. 5 cols.—*Mech. Engr.*, Feb. 3rd, 1900.

4. Telegraphy and Telephony.

Telegraphy.—*Wireless Telegraphy.* By G. W. de Tunzelmann, B.Sc. This is the first of a series of articles by the above-named author on the subject of wireless telegraphy. Discussing the properties of the so-called "aether," the author tries to explain them by showing an analogous behaviour, as regards resistance to motions of various speeds, of ordinary pitch. In moderately cold weather this substance will have the appearance of a solid, and resist a blow or momentary heavy pressure. If, however, a denser body, a leaden bullet, for instance, is placed upon it, it will gradually work itself downward to the bottom, while if pitch rests upon a less dense body, such as a cork, the latter will work its way upward to the surface. The article in general deals with the earlier experiments up to the time of the research made by Mr. W. H. (now Sir William) Preece in 1882. 7½ cols.—*Knowledge*, Feb. 1900.

—— *High Speed Automatic Telegraphy.* Description of the Pollak-Virag system, giving a clear idea of the working of the apparatus, which is very ingenious, but has been declared both by American and French experts to be unpractical for ordinary use, as the various translations necessary, and the preparing of the slips, require too much time. (Ill.) 2¼ cols.—*Mod. Mach.*, Jan. 1st, 1900.

—— *Cables, their Importance for the World's Commerce, and the Cable Steamer "Von Podbielski."* The article dwells on the danger for other nations arising from England's monopoly of the great inter-oceanic cables, and the urgent necessity for a development of a cable system belonging to Germany. 14½ cols.—*Stahl u. Eisen*, Feb. 15th, 1900.

—— *Mr. Marconi on Wireless Telegraphy.* Summary of a lecture delivered by Mr. Marconi at the Royal Institution, in which, after pointing out that an improvement had recently been made which consisted of inserting the secondary of a transformer or induction coil in the coherer circuit whose function was to increase the electro-motive force of the induced oscillations at the terminus of the coherer, he referred to the installations erected between the South Foreland and Wimereux, the messages sent from the "Europa" to the "Juno" (60 miles), the installations made by his assistants at the front in South Africa, etc. 1¾ col. *Mech. Engr.*, Feb. 10th, 1900.

Telegraphy.—*Equipment of a Cable-Testing Station.* Description of the equipment and the working of a cable-testing station, such as is necessary in connection with every cable works. 2½ cols.—*Electrotechniker*, Feb. 15th, 1900.

Telephones.—*The "Central Energy" Multiplied Switchboard Independent Telephone Exchange, Parkersburg, W. Va.* Description of a modern very complete installation of the "Independent" type. The system is the so-called "Central Energy" system. (Ill.). 1½ col.—*Elec. Engr.*, Jan. 27th, 1900.

5. Miscellaneous.

Aluminium.—*Aluminium and its Uses and Treatment in Electrical Engineering.* Short abstract of a paper by J. H. Henderson, read before the Soc. of the Manchester Junior Electrical Engineers, describing the best methods of the extraction of the metal from the ore by electrolysis; its peculiarities as an electrical conductor, its treatment in the foundry, etc. 1 col.—*Mech. World*, Feb. 2nd, 1900.

Accumulators.—*Transportable Watt-Dry Accumulator.* By Dr. R. Kieseritzky. Description of dry accumulators placed on the market by the Watt-Accumulator Works at Zehdenick-on-Havel. 3½ cols.—*Elektrotechniker*, Jan. 15th, 1900.

Electrical Applications.—*Blasting by Electricity.* Abstract of a paper by Mr. Claude H. Smith read before the Technical and Engineering Society of Golden, Col., U.S.A. The author having dealt with the various parts of the system, discusses the advantages and disadvantages. 2 cols.—*Electricity* (London), Jan. 26th, 1900.

—— *Electricity as Applied to the Production and Application of Colouring Matters.* Description of methods in which Prof. Gopelsröder, of Mühlhausen, was the pioneer, and of other systems. 3½ cols.—*Elec. Chem. Rev.*, Jan. 1900.

Electric Cranes.—*Cantilever Cranes.* By Waldon Fawcett. Description of electric, balanced, cantilever shipbuilding cranes, the invention of which has rendered obsolete the former methods, and which are certain of introduction in all canal work of great magnitude, these cranes being excellently adapted not only to the loading and unloading of vessels but to the handling of material from large excavation, open-pit mine work, the transference of plates, frames, and armour in shipbuilding yards, etc. (Ill.) 2½ cols.—*Sci. Am.*, Feb. 10th, 1900.

Electrical Engineering. — *Standardisation of Plant.* Abstract of a paper by Mr. R. Percy Sellon, read before the Institution of Electrical Engineers. The author recommended standardisation as a means of cheapening production and meeting foreign competition; standardisation of "ends" or "performance" as distinct from "means" or "constructional details." The relative absence of standardisation in Great Britain in contrast with other countries he ascribed to the prevailing system wherein the user's consulting "engineer" specifies "means" or "constructional details" instead of confining himself to "ends" or "performance." Finally, he emphasised the fact that the determination of standards should result from organised effort, and be undertaken under the auspices of the "Institution of Electrical Engineers." 3¼ cols. — *Lightning*, Feb. 5th, 1900.

Electrical Measurements.—*The Construction of a Voltmeter and Ammeter Suitable for a Small Switchboard.* By Nevil Monroe Hopkins. The article is taken from the *American Electrician*, and contains directions for making simple forms of indicating instruments, and for their calibration and care. (To be continued.) 4½ cols.—*Electricity* (London), Jan. 19th, 1900.

—— *The Construction of a Voltmeter and Ammeter Suitable for a Small Switchboard.* Abstract of a paper by Mr. Nevil Monroe Hopkins. (Conclusion.) 4½ cols.—*Electricity* (London), Jan. 26th, 1900.

Electrical Museum.—*The Electrical Collections in the Smithsonian Institution and the National Museum.* I. By Geo. C. Maynard. The article describes the appearance and history of the Smithsonian Institution and its collections, notably the electrical. (Ill.) 5 cols.—*Elec. Rev.* (New York), Jan. 3rd, 1900.

Electric Heating. *Electric Heating Apparatus.* Description of a new and improved electric heater recently placed on the market by the Gold Car Heating Co., of Frankfort and Cliff Streets, New York. (Ill.). 1 col.—*Elec. Rev.* (New York), Jan. 3rd, 1900.

Electrical Industry. *The Position of Electrical Industry.* A noteworthy article sounding a note of warning. The editor points out that electrical industries in Great Britain are in a somewhat critical condition. Many of the companies are over-capitalised, and this is not due to any desire of carrying out work on an extensive scale, but because heavy sums have been paid out to promoters and vendors. The fact that electrical manufacturers and supply companies are just at present obtaining better returns enables unsound enterprise to find supporters. Though the prospects of electrical undertakings are promising, it is a pity that so often great sums are expended for buying up the patents and working processes of systems which have not been proved either technically or commercially. To this must be added the great number of breakdowns and the inability to keep the engagements with consumers, because more subscribers have been accepted than can be supplied simultaneously. 3 cols. *Mech. Engr.*—Jan. 20th, 1900.

Electricity as an "Article." *Is Electricity an "Article" subject to Duty?* A Washington despatch states that the officials of the Treasury Department are considering a proposition to levy a tariff duty on an electric current generated in Canada and conducted across the border into the United States. The question was raised by the Niagara Falls Power Company, of Niagara Falls, N.Y., against the Ontario Power Company, its rival across the river at Niagara Falls, Ont., which threatens a serious competition. The article points out that if it is decided to impose an import duty on the current, it could be done only under the "drag-net clause" of the Dingley Law, which makes all unenumerated manufactured articles dutiable at 20 per cent. *ad valorem.* ⅛ col.—*Engr.* (Cleveland). Jan. 1st, 1900.

Electricity. *The Electrification of the Atmosphere.* Summary of a report recently issued by the United States Weather Bureau, describing the experiments made by several American meteorologists, notably Mr. Alexander McAddie and Mr. Frank Eddy, for the purpose of studying atmospheric elecricity. 5½ cols.—*Engng.*, Jan. 5th, 1900.

—— *American Electrical Progress in* 1899. By Charles T. Child. The author points out that the comparatively unprogressive development of the electrical industry in the United States during the past year is due to the limitations set by an enormous and increasing activity in all directions. 8 cols.—*Elec. Rev.* (New York), Jan. 3rd, 1900.

Electric Pumps. *Powerful Electric Pumps at Austin, Texas.* Description of a pump constructed by the city for the purpose of securing filtered water. This pump is driven by a synchronous motor built by the General Electric Company, running 600 revolutions per minute. (Ill.). 1½ cols. —*Sci. Am.*, Jan. 13th, 1900.

Magnetic Curves. *Hysteresis Curves in Samples of Iron and Steel.* Abstract of a paper by Prof. Knut Angström read before the Royal Academy of Science in Copenhagen. The author describes a beautiful method of experimentation for studying these curves, and expresses the opinion that this method may be adapted to practical use in testing samples of iron, both for their magnetic qualities and also for their carbon contents. (Ill.). 2½ cols. —*Elec. Rev.*, Jan. 10th, 1900.

Magnetic Leakage.—*A Graphical Treatment of the Effect of Magnetic Leakage on Transformer Regulation.* By F. G. Baum. The author describes a method of determining the regulation of a transformer in such a form as to be available to practical men. 2⅝ cols.—*Elec. Wld. and Engr.*, Jan. 13th, 1900.

MARINE ENGINEERING AND SHIPBUILDING.

Docks.—*Floating Dry Docks in America.* By Walden Fawcett. Less than a year, says the author, will suffice to place the Navy Department of the United States in a pre-eminent position among the nations of the world, in so far as its floating dry-docks facilities are concerned. The United States Navy Department was practically destitute of floating dock facilities at the beginning of the Spanish-American War, but at that time purchased one dock complete, which, though rather small, will still be very useful for smaller vessels, but since it has contracted for the erection of the largest floating dry-dock in the world. This steel floating dry-dock is building at the yard of the Maryland Steel Company, Sparrow's Point, Md., and was designed by Clark and Standfield, the well-known London engineers. It is to be stationed at Algiers, La., near the mouth of the Mississippi. (Ill.). 2½ cols.—*Mod. Mach.*, Jan. 1st, 1900.

Collisions at Sea.—*Means for Avoiding Collisions at Sea.* Summary of an article by G. Hamelin in the "Revue Universelle," containing a review of the various devices invented with the object of avoiding collisions at sea, including a description of the electro-automatic signalling boat at Obecchioni. 5 cols.—*Dingler's Polyt. Journ.*, Feb. 17th, 1900.

Marine Engineering.—*Marine Mechanical Stoker.* By Christian Larsen. Description of a mechanical stoker put upon the market by the American Stoker Company, New York, and used in three boilers of the Continental Iron Works, Brooklyn, in the Ridgewood Station of the Brooklyn Waterworks, and in boilers of the United Verde Copper Company at Jerome, Arizone. (Ill.). 1½ col.—*Am. Mfctr.*, Jan. 25th, 1900.

Steamers.—*The "Deutschland."* Short description of the dimensions of this new steamer of the Hamburg-American Line, built and engined by the Vulcan Company, Stettin, launched on the 10th inst., the largest ship in the world, though not intended to have an exceptional speed. She has a loaded displacement of 23,000 tons. (Ill.). ⅛ col.—*Engr.*, Jan. 26th, 1900.

—— *The North German Lloyd and its Twin-Screw Steamer "Kaiser Wilhelm der Grosse."* (Conclusion.) The article describes fully the auxiliary engines and the electrical equipment of this magnificent steamer, which is surpassed in speed only by the "Deutschland." (Ill.). 9 cols.—*Dingler's Polyt. Journ.*, Feb. 3rd, 1900

—— *Mechanical Stokers.* Description of these mechanical underfed stokers, of which three are fitted to each boiler, and which were manufactured by the American Stoker Company. Each of them consists essentially of a central magazine, a coal hopper, a screw conveyor, a wind-box, cast iron air-blocks, and an independent steam motor. (Ill.). 3½ cols.—*Engr.*, Jan. 26th, 1900.

MECHANICAL ENGINEERING.

1. Boilers, Furnaces, Fuel.

Cheap Fuel.—*The Schwartzkopff System of Coal Dust Firing.* Reproduction of the main points of an article on this well-known method from the "Iron and Coal Trades Review." 1⅝ col.—*Gas Wrld*, Feb. 3rd, 1900.

Furnaces.—*A German Brass Furnace.* Account of a furnace in which the metal is melted in one

large crucible, and afterwards distributed in smaller ones, from which it is poured into moulds. This furnace was designed by Mr. Robert Wagner, of Schonan, near Chemnitz, Germany. 1¼ col.—*Mech. Engr.*, Feb. 10th, 1900.

Boiler Testing.—*Boilers Inspection and Registration.* Full text of a Bill put forward last year and reintroduced this year, "to provide for the inspection and registration of boilers," prepared by and brought in by Mr. Fenwick, Mr. John Wilson (Durham), Mr. William Allan, Mr. Woods. Mr. J. Samuel, and Mr. Joseph Walton. 3¾ cols.—*Mech. Engr.*, Feb. 10th, 1900.

Boilers.—*The Economical Generation of Steam Power.* By Benjamin A. Tapp. (Conclusion.) The present instalment is devoted to some general remarks on the subject of machine stoking, its design and efficiency. (Ill.) 3 cols.—*Elec. Engr.*, Feb. 9th, 1900.

2. Compressed Air.

Compressed Gases.—*Compression and Liquefaction of Gases.* (Conclusion.) Abstract of a paper by Mr. Arthur L. Rice, presented at the New York meeting of the Am. Soc. of Mech. Engrs., describing the result of the researches made by Tripler, Linde, Hampson, A.O. 5½ cols.—*Mech. Engr.*, Feb. 3rd, 1900.

3. Engines and Motors.

Automobiles.—*Competitive Tests of Accumulators in France.* By A. de Pourey. Summary of the official report of the committee appointed by the Automobile Club of France, intrusted with the making of a series of competitive tests of accumulators. 1¼ col.—*West. Elec.*, Feb. 3rd, 1900.

—— *American Types of Automobiles.* VII. Account of the so-called Hub-Surrey which has four motors each of a four-pole type, developing a normal 1½ brake h.-p. The hubs measure only 10½ inches in exterior diameter. The batteries are storage, 40 cells being used of 80 amp.-hours at a 3-hour discharge rate. The wheels are 43 in. in diameter of wood, or with 3 in. Stoddar unpuncturable pneumatic tires. The total weight of the vehicle is put at 3,000 pounds. 1¼ col.—*Elec. Wrld. and Engr.*

—— *The Serpollet Superheated Steam Motor.* Description of a motor designed for use with highly superheated steam, the temperature of which may be from 400° C. to 500° C.; for this it is necessary to dispense entirely with oil lubricants and packings. (Ill.) 1¼ col.—*Automotor*, Feb. 15th, 1900.

—— *Typical Automobile Systems.* By Prof. Bachner, Stuttgart. (Continuation.) The present article deals with the various methods of ignition. (Ill.) 5¾ cols.—*Dingler's Polyt. Journ.*, Feb. 3rd, 1900.

—— *Typical Automobile Systems.* By Prof. H. Bachner, Stuttgart. (Continuation.) The article concludes the account of methods of ignition, and proceeds to deal with the means of regulating speed. (Ill.) 9¼ cols.—*Dingler's Polyt. Journ.*, Feb. 10th, 1900.

—— *Automobiles—Old and New.* Article describing and illustrating some of the prototypes of modern automobiles, accompanied by reproductions of very interesting prints dating back to the end of the last and beginning of the present centuries, which show that the present development was even then foreseen. 2 cols.—*Mod. Mach.*, Jan. 1st, 1900.

—— *The Thornycroft Steam Wagon Company.* Full description of the newly erected works of the Thornycroft Steam Wagon Company (Limited), at Basingstoke, Hants. (Ill.) 3¼ cols.—*Automotor*, Feb. 15th, 1900.

—— *American Types of Automobiles.* The vehicle described is manufactured by E. C. Stearns and Co., of Syracuse, N. Y., and belongs to the lighter order of "runabout" of the Stanhope type. (Ill.) 2 cols.—*Elec. Wrld. and Engr.*, Jan. 27th, 1900.

Gas Engines.—*Benzine Locomotives a Success.* In Germany a notable measure of success has been attained in the development of the idea of using the gas motor in locomotive work. The Otto Gas Engine Company has led in this development. The article deals with benzine (gasoline) motors of the Otto type constructed in Chicago. (Ill.). 1¼ col.—*Railw. Mast. Mech.*, Feb. 19th, 1900.

—— *Gas and Gasoline Engines.* Description of the Meitz and Weiss direct-coupled generator and kerosine engine. (Ill.). 1 col.—*Mod. Mach.*

—— *Blast-Furnace Gas Engines.* By J. D. Lyon. Description of a 600 h.-p. Deutz "Otto" gas engine of the type adopted for large powers, and two 300 h.-p. double-cylinder engines, directly connected to generators. (Ill.). 1¼ col.—*Am. Mafstr.*, June 18th, 1900.

—— *Cornell Gas Engine.* Description of a gas and gasoline engine of the vertical double-cylinder type for the purpose of electric lighting, introduced by the Cornell Machine Company of Chicago. (Ill.). 1¼ col.—*West. Electr.*, Jan. 27th, 1900.

—— *Test of a Gas Engine.* A paper by C. H. Robertson, Lafayette, Ind., read before the American Society of Mechanical Engineers, describing the working and the result of an efficiency test of a 125 h.-p. gas engine. (Ill.) 6¼ cols.—*Engng.*, Jan. 28th, 1900.

—— *Test of a 125 h.-p. Gas Engine.* By C. H. Robertson (conclusion). The tests were undertaken with the object of securing reliable data concerning the power developed, the gas consumed, the speed regulation, heat given to jackets, etc. 6 cols.—*Mech. Engr.*, Feb. 10th, 1900.

Oil Engines.—*The Diesel Oil Engine.* Description of an oil engine which has excited more theoretical interest than any other in Germany, for the inventor has been studying the subject of the utilisation of heat in gas and oil engines for about 15 years, and is known as the author of a small book entitled "Theory and Construction of a Rational Heat Motor." (Ill.) 7 cols.—*Engng.*, Jan. 5th, 1900.

Transport.—*The Biggest Horse-Drawn Wagon yet built.* Short account of an enormous wagon built for being used in Arizona, where horses are very cheap. The height from ground to top of the seat is 13 ft. The hubs are 16 in. by 20 in., and the spokes 4½ in. The front wheels are 5 ft. in diameter and the rear wheels are 8 ft. The wagon bed is 20 ft. long, and has a regular width of 3 ft. 8 in. The complete wagon weighs 6,515 lbs., and has a carrying capacity of 12 tons. It measures 33 ft. from the tip of the pole to the back of the bed. It was built for the Fortuna Mining Company, Fortuna, Yuma County, Arizona, by Messrs. M. P. Henderson & Son, of Stockton, California. (Ill.) ¼ col.—*Automotor*, Feb. 15th, 1900.

—— *Plateways.* Abstract of a paper read by A. Holt, Esq., M.I.C.E., M.I.N.A., etc., before the Students' Engineering Society of University College, Liverpool, Jan. 16th, 1900, on the Lancashire Plateway and the plateway system itself. 5½ cols.—*Automotor*, Feb. 15th, 1900.

Turbines.—*Steam Turbines.* Summary of a lecture delivered by the Hon. C. A. Parsons, before the Royal Institution, in which, after a short allusion to the turbines described by Hero, of Alexandria, and other ancient forms, the lecturer gives an account of the improvement of modern turbines and their prospects in marine engineering. 1¼ col.—*Iron and Steel Trades Journ.*

4. Power and Transmission.

5. Machine Works, Shop and Foundry.

Brassfounding. — *Light Brassfounding.* By C. Vickers. The author describes the great difference of method in what is called "heavy" and "light" founding, and dwells on the import-

ance as regards the latter of fine saws, the use of lycopodium, and a correct mixture, such as copper 16 lb., and 1 lb. of each zinc, tin, and lead. 1⅛ col. —*Mech. World*, Oct. 2nd, 1900.

Filing.—*Practical Talks on Files. I.* By W. H. Vandervort. The author describes the correct and faulty methods of handling files, and gives many useful hints to workmen. (Ill.) 2 cols.—*Mod. Mach.*, Jan. 1st, 1900.

Foundry.—*The Colour Names for High Temperatures.* By Henry M. Howe. Article based upon an important paper by Messrs. Maunsel White and F. W. Taylor, read before the Amer. Soc. of Mech. Engrs., stating in degrees of Fahrenheit or Centigrade the temperatures to which correspond various colours of the molten metal. 2 cols.—*Engng. and Min. Journ.*, Jan. 20th, 1900.

—— *The Walker and Pratt Foundry at Watertown, Mass.* Description of the equipment and working of the new installation of this old and successful business, whose speciality is the manufacture of stoves and of hot air and hot water furnaces. (Ill.) 9 cols.—*Am. Mach.*, Feb. 1st, 1900.

Lathe.—*Hexagon Turret Lathe.* Description of a lathe representing the latest improvements in turret-lathe design, brought out by Mr. Alfred Herbert of Coventry, and capable of taking bars through the hollow mandril up to 2 in. in diameter, and operating on 27 in. of length. (Ill.) 4 cols. —*Mech. Engr.*, Feb. 10th, 1900.

Machine Shop Equipment. — *Originating an Index Plate.* Description of the index plate used in the Pope Manufacturing Co. for bicycles. The index plates used in the gear-cutting machines at these works are special for each gear—plate and gear having the same number of teeth. (Ill.) 4 cols.—*Am. Mach.*, Feb. 1st, 1900.

Machine Tools.—*Liquid-Operated Machine Tools.* Some modern inventors believe that it is advantageous to use liquid pressure to operate the moving parts of machine tools in place of the usual mechanical elements, such as gears, racks and pinions, feed-screws, etc. The author of this article, Mr. H. A. Coombs, has made a research in the American Patent Office to see what has been accomplished in this line, and studied the patents for hydraulically-operated machine tools, of which he gives a summary in the present article. 5 cols. —*Am. Mach.*, Feb. 1st, 1900.

—— *American Machine Tools. I.* This is the first of a series of articles on the subject, and after a general introduction the author proceeds to describe a turret lathe of 20 in. swing, built by Fay and Scott, of Dexter, Maine, U.S.A. (Ill.) 2¾ cols.—*Engr.*, Feb. 16th, 1900.

Screw-Cutting.—*A Lag-Screw Cutting Machine.* Description of a machine designed for cutting screw threads upon lag-screws, which it does by a novel method. The machine is constructed by Baker Brothers, Toledo, Ohio. (Ill.) 3 cols.—*Am. Mach.*, Jan. 25, 1900.

Screw Making.—*The Standardisation of Screw Threads.* (Continued.) The author deals with the proposal which the Federal Council of Switzerland will make at the third International Conference for the unification of railways at Berne, and with the more important of the various systems of screw threads, *i.e.*, those of Whitworth, Armengaud, Bodauer, Denis Poulet, etc. (To be continued.) 4¾ cols.—*Engng.*, Jan. 26th, 1900.

Screw Threads.—*The Standardisation of Screw Threads.* The author points out that, although Whitworth's standard screw thread, elaborated 60 years ago, was excellent in its way, and was generally adopted not only in Great Britain, but also in Germany, and, to some extent, in the United States, it must be, sooner or later, superseded by a standard based on a metric system, for we no longer hold the lead in manufacturing so securely that we can force feet and inches upon our foreign customers. 3¾ cols.—*Engng.*, Jan. 19th, 1900.

Spiral Gears.—*Some Points about cutting Spiral Gears. A Spiral-Gear Cutting Machine.* By A. L. De Leeuw. The author first gives some hints regarding the most practical method of cutting spiral gears, and then describes a machine built at the Niles Tool Works, intended to cut spiral gears from 6 to 36 in. diameter, with pitches from 2 to 6 diameter pitch, and with 45-degree angle only, either right- or left-hand.—*Am. Mach.*, Jan. 11th, 1900.

6. Miscellaneous.

Bicycles.—*Half a Century in the Development of the Bicycle.* Descriptions, accompanied by illustrations, of a valuable collection of historic bicycles, illustrating the youth of the machine from 1850 to 1900, exhibited by the American Bicycle Company, at Madison Square Garden, New York. 2½ cols.—*Sci. Am.*, Feb. 10th, 1900.

Emery Wheels.—*The Plant of the Norton Emery Wheel Company.* Full description of the plant and the working of the Norton Works, at Worcester, Mass., for the manufacture of emery wheels. (Ill.) 7½ cols.—*Am. Mach.*, Jan. 25th, 1900.

Fans.—*Screw Fans.* Abstract of a paper by Charles H. Innes, read before the North-East Coast Institution of Engineers and Shipbuilders. The article gives a detailed description of screw fans which, where space is limited and a large volume of air is required, are preferable to centrifugal fans. (Ill.) 3 cols.—*Engng.*, Jan. 12th, 1900.

Flying Machines.—*The Danilewski Flying Machine.* Description of experiments with a flying machine, invented by Dr. K. Danilewski, of Charkow, Russia, conducted under the auspices of the Russian Government, which proved very successful. (Ill.) 1 col.—*Sci. Am.*, Jan. 20th., 1900.

Lubricants.—*Air as a Lubricant for a Journal Bearing.* Atmospheric air is now being used with good results for illustrating the action of a lubricant in an ordinary journal bearing, in a machine designed by Prof. Albert Kingsbury, of the mechanical department of the Worcester Polytechnic Institute, U.S.A. The author of the article, Mr. Herman S. Herchert, describes experiments made with this object in view. 3 cols.—*Am. Mach.*, Feb. 1st., 1900.

Measurements of Steam.—*Measurements of Steam and Water.* The article describes the most ordinary methods and appliances in use, such as single measuring tanks, continuous measuring tanks, measurement of steam by weight, etc.—*Mech. Engr.*, Jan. 27th, 1900.

Metric System.—*The Adoption of the Metric System in England.* Abstract of a paper read at the English Educational Exhibition in the Imperial Institute, on Jan. 9th, by Mr. J. J. Alexander, M.A., Headmaster of the Tavistock Grammar Schools, advocating a Bill fixing a limit of time for the general adoption of the metric system in England. (To be continued.) 4 cols.—*Chamb. of Comm. Journ.*, Feb., 1900.

Paper Manufacture.—*Highly Glazed Surface Papers.* By Robert Irvine. The author points out that the highly glazed surface papers now-a-days employed for process printing, notwithstanding the beautiful effects obtained with them, possess many serious defects. In the first place, the printed impressions are made upon the surfacing material, and not upon the paper at all, which renders it quite possible to remove with a little water the printing together with the coating: in the second place, the minerals employed for the coating render books printed on such papers very heavy; the papers, if exposed to damp and heat,

would probably decompose and give rise to products having an unpleasant smell. By passing the coated sheets while moist through a bath containing formalin, the gelatine is rendered insoluble in water, and thus the liability to destruction is partly removed. 1¼ col.—*Brit. & Col. Print. & Stationer*, Feb. 1st, 1900.

Pipe-Fittings.—*Automatic Tapping Machine for Pipe Fittings.* Description of an automatic machine specially designed for securing different sizes of gas and steam fittings, with a minimum of labour and the least possible waste of time. (Ill.). ½ col.—*Engng.*, Jan. 5th, 1900.

Roller Flour Milling.—*Further Developments of Roller Flour Milling.* II. By W. R. Voller. A short review of the modern conditions surrounding the now universally adopted gradual reduction system. 3 cols.—*The Miller*, Feb. 5th, 1900.

—— *Should Break Rolls be Dull?* By Mr. Frank Stacey. A reply to an article by Mr. Bates in which the latter appears to have advocated "dull corrugations, a large quantity of break flour, and few, if any, middlings," which the author declares to be absurd. 4½ cols.—*Mod. Mach.*, Jan. 1900.

Refrigeration.—*Mechanical Refrigeration.* By Mr. Luhr. Descriptive account of the various methods used in mechanical refrigeration. 5½ cols.—*Power*, Jan., 1900.

Theodolite.—*Lister's Inclinometer Theodolite.* Description of an improved inclinometer theodolite being now constructed by Mr. W. F. Stanley, of the Great Turnstile, High Holborn, London. Owing to certain peculiarities of design this instrument is capable of doing rapid work, which in the ordinary way can be done only slowly and in a laborious fashion. The feature which distinguishes the instrument consists in the mounting of the telescope on a supplemental axis, at right angles to the ordinary transverse axis. 1½ cols.—*Engnr.*, Jan. 12th, 1900.

Thermometers.—*The Pneumatic Pyrometer and Autographic Recording Gauge.* Abstract of a paper by Mr. Edward A. Uehling, read before the meeting of the Cleveland Institution of Engineers held at Middlesborough. The author therein describes what he calls a "Pneumatic Pyrometer and Autographic Recording Gauge," which is an instrument capable of measuring temperatures above the range of the mercury thermometer, based on the laws governing the flow of air through small apertures. 2 cols.—*Mech. Engr.*, Feb. 3rd, 1900.

Vacuum Pumps.—*Vacuum Pumps for Chemical Work.* Description of an installation recently erected at the works of Messrs. David Thorn, Domeier & Co., Ltd., Pendleton, Manchester, by the Klein Engng. Co. (Ill.). 1 col.—*Chem. Trade Journ.*, Jan. 20th, 1900.

Wire Works.—*Wire and Wire Drawing.* Abstract of a paper by Mr. J. Dixon Brunton, read before the West of Scotland Iron and Steel Inst., dealing with iron and steel wire, and their most important uses. 2½ cols.—*Ir. and Coal Trades Rev.*, Jan. 19th, 1900.

—— *Wire and Wire Drawing.* By Mr. J. Dixon Brunton, F.C.S. The author describes the *modus operandi* of wire drawing and the various methods of connecting, etc. 2½ cols.—*Ind. and Iron*, Feb. 9th, 1900.

—— *Development of Wire Works, with special reference to North America.* The article gives a historical review and a detailed description of wire works, notably in the United States. The author is Mr. Michael Baaches, of Cleveland, O., U.S.A. 22 cols.—*Stahl u. Eisen*, Jan. 15th, 1900.

MINING AND METALLURGY.

1. Coal and Coke.

Coal Mining.—*Coal in* 1899. This article deals with the coal output in the United States during last year which has been the largest on record. 4½ cols.—*Engng. and Min. Journ.*, Jan. 6th, 1900.

2. Copper.

3. Gold, Silver, and Diamonds.

Gold Mining.—*Gold in Siberia.* Summary of the translation of the report by Mr. Bogdanowich, a distinguished Russian engineer, presented to the Russian Government, and giving the results of the expedition undertaken under his guidance to the shores of the Sea of Okhotsk, the coast of Kamchatka, and the Shantar Islands. This report mentions several districts where gold deposits were found, the development of which by private enterprise might prove profitable. 2 cols.—*Mod. Mach.*, Jan. 1st, 1900.

4. Iron and Steel.

Pig Iron.—*Comments on Pig Iron Selling.* By George H Hull. Abstract of a paper read before the American Foundrymen's Association Meeting, Feb. 7th, 1900. The author discusses the Syndicate System of Germany, the Warrant System of Great Britain, and the Selling Methods in the United States. 4¾ cols.—*Am. Mfctrr.*, Feb. 8th, 1900.

Iron and Steel.—*The Metallurgy of Iron and Steel.* By Prof. Humboldt Sexton. (Continuation.) The present instalment deals with the preparation of malleable iron, puddling, the furnace, making the bottom, working a charge, etc. (Ill.). 6 cols.—*Mech. Engr.*, Feb. 17th, 1900.

Ironworks.—*Ironworks of the Deutscher Kaiser Company at Bruckhausen on Rhine.* Summary description of the plant of these ironworks which are among the largest and most productive in the Rhenish Westphalian district, Germany. They were established in 1890, and the proprietors own 25½ square miles of coalfields, containing at moderate depths numerous seams yielding gas, furnace and coking coals in large quantity. ¾ col.—*Mech. World*, Feb. 2nd, 1900.

—— *Endless-rope Haulage at the Coke Ovens of the Röchling Works.* Translation of an article in "Glückauf" describing the method of haulage in the Röchling Iron and Steel Works at Völklingen, that have a large 216-oven coke plant at Altenwald, in the district of Saarbrücken, Germany. (Ill.). 2½ cols.—*Iron and Coal Trds. Rev.*, Feb. 9th, 1900.

—— *The Works and Operations of Palmer's Shipbuilding and Iron Company.* Extracts referring to blast-furnaces, foundry-work, steel manufacture, etc., from a monograph published some time ago by Mr. M. Dillon, Secretary of Palmer's Shipbuilding and Iron Company. (Ill.). 3 cols.—*Iron and Coal Trades Rev.*, Feb. 16th, 1900.

Ironworks Equipment.—*Economy in the Transport of Raw Material for Iron Work. II.* The article describes various plants for the economical transport of ores and coal from the mines to the ironworks. (Ill.). 9½ cols.—*Stahl u. Eisen*, Feb. 1st, 1900.

Iron Mining.—*Iron Ore—from Mine to Furnace.* By Waldon Fawcett. Description of the methods employed in the transportation of iron ore from the mines in the district surrounding Lake Superior to the furnaces in the Mahoning Valley and the vicinity of Pittsburg. (Ill.). 1½ col.—*Engng. and Min. Journ.*, Jan. 20th, 1900.

Separator.—*Electro-Magnetic Separator.* Account of a very practical electro-magnetic separator, invented by Mr. J. Brownilow, for removing iron and steel borings from those of other metals, particularly brass and gun-metal. The machine is very simple and works with very little attention. (Ill.). ½ col.—*Engng.*, Jan. 26th, 1900.

Steel.—*The Pressing of Steel with especial reference to Economy in Transportation.* By Henrik V. Loss. (Continuation). Abstract of a paper read before the Mechanical and Engineering section of the Franklin Institute, Nov. 9th, 1899. 5 cols.—*Mech. Engr.*, Feb. 10th, 1900.

Steel.—*Nickel Steel.* By David H. Browne Continued.) The present instalment deals with the "Elastic limit and ultimate strength, elongation and contraction of area, proportion of elastic limit to ultimate strength," etc. (Ill.). 6 cols.—*Mech. Engr.*, Feb. 17th, 1900.

5. Mining and Metallurgy.

Mine Ventilation.—*Root Principles of Mine Ventilation.* The article discusses the theory of the diameter and width of fans, pointing out that there are at least two standpoints from which the question of density of the air can be treated, and dealing with the subject in its various bearings. 6¾ cols.—*Coll. Guard.*, Feb. 9th, 1900.

Mine Equipment.—*Pumping Engine at a Westphalian Colliery.* Summary of an article by Bergassessor von Sobbe in the "Ztschrft. f. Berghau, Hütten u. Salinenwesen," describing a pumping engine constructed by Messrs. Haniel and Luez, of Dusseldorf, with the object of raising water—at an estimated flow of 3,300 gallons—from a depth of 220 yards in a flooded mine to about 76 yards below bank. (Ill.). 1½ col.—*Coll. Guard.*, Feb. 9th, 1900.

—— *Benzine Locomotive for Mine Haulage.* Translation of an article by E. Braun in the "Zeitschrift fur des Berg. Hütten und Salinenwesens," describing the work of a benzine locomotive brought out by the Duetz Gas Engine Co. (Ill.). 7½ cols.—*Iron and Coal Trades Rev.*

Mining.—*Dynamite Magazines at Slight Depths.* Summary of a report by the French Explosive Substances Commission on the Blauzy experiments, published in the "Annales des Mines," with the object of determining the laws according to which variations occur in the quantity of matters thrown forward by the explosion of variable charges, with different densities of charging and sunk at various depths. 4¼ cols.—*Coll. Guard.*, Feb. 9th, 1900.

—— *Mechanical Ore Unloader.* By Waldon Fawcett. Description of a mechanical ore unloader of a new type, the first of which has been recently installed in the docks of the Carnegie Steel Company at Connecticut, O. (Ill.). 2½ cols.—*Contract Journ.*, Jan. 31st, 1900.

—— *Lead in* 1899. Account of the lead production in the United States during last year. ⅝ col.—*Engng. & Min. Journ.*, Jan. 6th, 1900.

—— *Zinc in* 1899. Account of zinc production in the United States during last year. It largely exceeded that of any previous year. There was an increase in all the mining districts, while the Joplin region, including the mines in south-west Missouri and south-east Kansas, was the centre of phenomenal activity. ½ col.—*Engng. & Min. Journ.*, Jan. 6th, 1900.

—— *Tin in* 1899. There was no tin produced in the United States in 1899, and, as in previous years, they continued to be entirely dependent upon foreign markets for their supply. The article deals with tin imports and foreign productions. ½ col.—*Engng. & Min. Journ.*, Jan. 6th, 1900.

—— *Utah's Metal Mines in* 1899. The mining industry enjoyed steady progress, and a new record was made in the yield of smelted products. ⅝ col.—*Engng. & Min. Journ.*, Jan. 6th, 1900.

—— *Utah Mines in* 1899. Comments on the statistics of last year. Account of the copper fever, which led to the belief that new mines had been discovered in Utah, which, however, was not the case. 1½ col.—*Engng. & Min. Journ.*, Jan. 13th, 1900.

—— *Quicksilver in* 1899. As in previous years, almost the entire production of quicksilver in the United States came from the Californian mines. Outside of California the only production reported is 261 flasks from the Texas mines. The Oregon prospect, about which the promoters put forth such glowing accounts the previous year, has apparently been abandoned. The Californian mines generally did well throughout the year, and nearly all of them paid regular dividends. The export of quicksilver from the United States for the eleven months ending November reached a total of 1,224,607 lbs. 1 col.—*Engng. & Min. Journ.*, Jan. 6th, 1900.

6. Miscellaneous.

Alloys.—*Aluminium Zinc.* Description of the method employed in making aluminised zinc and of aluminium brass, the former being usually made to contain 5 or 10 per cent. of aluminium. 1 col.—*Mech. Engr.*, Feb. 3rd, 1900.

MUNICIPAL ENGINEERING.

1. Gas Supply.

Gas Lighting.—*The Dillwick-Fleischer Water Gas.* Description of a process that has attracted much attention, and is being used extensively on the Continent for various purposes of manufacturing. (Ill.). 4 cols.—*Engrg.*, Feb. 6th, 1900.

Gas Manufacture.—*The Recovery of Nitrogen in Coal Distillation.* Abstract of communication made by W. Carrock Anderson, M.A., D.Sc., and J. Roberts, F.C.S., to the Scottish Section of the Society of Chemical Industry. 7 cols.—*Journ. of Gas Lighting*, Feb. 6th, 1900.

—— *Industrial Gas. IX.* By Frank H. Bates. Description of the Junter Calorimeter, an instrument especially suited to the continuous determination of the calorific power of a gas or liquid, since it not only serves to show the heat value of a product at any given time, but additionally all fluctuations occurring at various stages of the process. The author gives a detailed description of the construction and the working of the apparatus. (Ill.). 4½ cols. *Journ. of Elec. Power and Gas*, Dec., 1899.

—— *Photometry.* Extracts from an address delivered before the last annual meeting of the Société Technique du Gaz en France by its President, M. Vautier, referring to photometry in England, Germany, and France. (Ill.). 3¼ cols. *Gas Wrld.*, Jan. 20th, 1900.

—— *A De Brouwer Coke-Conveyor and a Carburetted Water-Gas Plant at the Crystal Palace Gas Works.* Description of a plant devised by Mr. Sydney Y. Shoubridge, Engineer of the Company, now under construction. 5 cols. *Journ. of Gas Lghtng.*, Jan. 23rd, 1900.

—— *The Everett Coke-Oven Gas Plant.* Summary of an article in *Progressive Age* by Dr F. Schniewind, of the United Coke and Gas Company, Boston, on the composition of the gas produced by the above-named plant. 1½ cols. *Journ. of Gas Lghtng.*, Jan. 23rd, 1900.

Gas Works.—*Labour-Saving Machinery in Gas Works.* Abstract of an article by Mr. J. T. Westcott, Manager of the Economical Gas Apparatus Construction Company, Ltd., which deals with the improvements that have of late years been effected in the plant of gas works, especially with reference to the saving of manual labour. 2½ cols. *Journ. of Gas Lghtng.*, Jan. 16th, 1900.

2. Sewerage.

Sewerage.—*Experiments on Sewage Purification at the Lawrence Experiment Station during* 1898. Account of experiments during the eleventh year at the station at Lawrence, Mass., for the purification of sewage and water, the establishment of which, twelve years ago, has brought international fame to the Massachusetts' State Board of Health. 3¼ cols.—*Engng. News*, Dec. 21st, 1899.

—— *Sewage Filtration through Coal.* Abstract of an interesting paper by Prof. A. Bostock Hill and Mr. Joseph Garfield, describing some investigations of the filtration of sewage through coal, part

of which were made at Lichfield. 2½ cols.—*Engng. Rcd.*, Feb. 3rd, 1900.

Sewerage.—*The Scott-Moncrieff System of Sewage Disposal.* Outline of the improvements in, and the latest installations of, a system of sewage treatment on scientific bacterial lines without chemicals, which is one of the oldest of the kind in existence, and has proved very successful. (Ill.) 3½ cols.—*Engr.*, Jan. 26th, 1900.

3. Streets and Pavement.

4. Water Supply.

Water Meters—*Water Meters: with Special Reference to Small Flows and Waste in Dribbles.* By Mr. Wm. Schönhelder, M.I.Mech.E. (Conclusion.) Abstract of a paper read before the Institution of Mechanical Engineers. The present portion deals with "Positive Meters." (Ill.) 6½ cols.—*Mech. Engr.*, Feb. 16th, 1900.

—— *Water Meters: with Reference to Small Flows and Waste Dribbles.* Abstract of a paper by Mr. Wm. Schönhelder, read before the General Meeting of the Institution of Mechanical Engineers, describing the characteristics of the low-pressure meters, inferential meters, volume or capacity meters, those of the Venturi class, waste-detection meters, positive meters, etc. 6 cols.—*Journ. of Gas Lighting*, Feb. 6th, 1900.

Waterworks.—*Reinforcement of the Walls of the Kansas City Settling Basins and the use of a Coagulant to aid Clarification.* By W. Kiersted, M. Am. Soc. C.E., Chief Engineer, Waterworks, Kansas City, Mo., U.S.A. The author points out that the original waterworks were constructed 1873-75, taking water from the Kaw, or Kansas River, that in 1888 the present supply works were completed, located on the banks of the Missouri River, about 6 miles from the old works, and that they passed into possession of Kansas City by purchase in 1895. After the purchase, he adds, the partition wall between basins 1 and 4 was almost entirely overthrown by water-pressure, and a general reinforcement of all the partition walls was known to have been made at considerable expense to the National Water Works Company. The writer, as engineer of the city, was requested to devise a plan for strengthening the walls, which is described in the article, together with the erection of a coagulant plant. (Ill.). 5 cols.—*Engng. News*, Jan. 4th, 1900.

The Incrustation of Iron Pipes at the Torquay Waterworks. A paper by Mr. W. Ingham, the Borough Water Engineer, of Torquay, read at a meeting of the Institution of Mechanical Engineers in October last. 7 cols.—*Journ. of Gas Lighting*, Jan. 16th, 1900.

—— *The Waterworks at Portland, England.* Account of the system of waterworks now nearing completion, based on a paper by Mr. Ernest J. Elford, Surveyor to the Urban District Council of Portland. (Ill.). 3½ cols.—*Engng. Recd.*, Jan. 13th, 1900.

—— *Melbourne Water Supply.* The article gives a short history of the gradual development of the Melbourne Waterworks. From 1886 to 1891 Melbourne's sole supply was the Yan Yean, but in that year the Watt's river scheme was completed, and the two combined, which are described in the present article, gives to the city and its numerous suburbs a water supply which is almost perfection in quantity and quality. 4½ cols. — *Engng.*, Jan. 5th, 1900.

—— *A Second Waterworks Plant for Vienna.*—Article dealing with the project of a new waterworks for the city of Vienna, for which water is to be derived from the so-called "Seven Lakes," in the region of the Enns River. 5½ cols.—*Ztschrft. d. Oest. Ing. und Arch. Ver.*, Feb. 9th, 1900.

5. Miscellaneous.

NAVAL AND MILITARY ENGINEERING.

Arsenals.—*Building Gun-Mounts at Watertown Arsenal.*—Description of the arsenal at Watertown (Mass.), which is mainly entrusted with the building of the carriages, turntables, elevating gear, etc., *i.e.* the "mounts" for the guns manufactured at Watervliet or elsewhere. 3¾ cols.—*Am. Mach.*, Jan. 11th, 1900.

Gun-Making.—*Messrs. Schneider & Co's. Works at Creusot. No. LXXVII.* The article continues the description of coast-defence guns and deals with a 24-centimetre (9·449 in.) coast-defence gun on central pivoted mounting, and a 27-centimetre coast-defence gun on muzzle-pivoting mounting. (Ill.). 2½ cols.—*Engng.*, Jan. 26th, 1900.

—— *Our Guns and their Use in War.* No. II. The article discusses the character and efficiency of the guns despatched to South Africa, grouping them under the headings of the work for which they are suited.

Gun Mountings. — *Elswick Naval Mountings.* No. II. Description of an 8-in. central-pivot mounting for swift cruisers. A considerable number of vessels, chiefly in foreign navies, is fitted with this form of mounting. (Ill.). ¾ col.—*Engr.*, Jan. 26th, 1900.

Military Matters.—*The Invisibility of the Soldier.* The author points out that the clothing of the British soldier in khaki is a correct return to nature which has long given examples of adaptation of colour to surroundings for the protection of animals; and deplores the conservative clinging of the Highlanders to their far visible dark tartans. 1⅛ cols.—*Sci. Am.*, Feb. 10th, 1900.

Warships.—*Reconstruction of Farragut's Flagship, the U.S.S. "Hartford"* Description of the transformation of this famous vessel, which acted as flagship on Aug. 5th, 1867, and forced its way through the almost impregnable Mobile Bay, and her equipment in modern style. (Ill.). 2 cols.—*Sci. Am. Suppl.*, Jan. 27th, 1900.

—— *H.M. Destroyer "Viper."* The short paragraph accompanying the illustrations gives the speed as 35·5 knots, or nearly 41 statute miles, and publishes the official data. (Ill.). ½ col.—*Engr.*, Feb. 16th, 1900.

RAILWAY WORKS.

1. Motive Power and Equipment.

Air Brakes.—*The First Air Brake. A short History; also Reminiscences of its First Engineer.* Account of the first train controlled by air brakes in America and also in the world, which was a local passenger train on the Pan Handle Railroad in 1869, and recollections of Daniel P. Tait, its engineer. (Ill.). 7 cols.—*Locom. Engng.*, Feb. 1900.

Boilers. — *Heat Transmission in Locomotive Boilers.* By William Forsyth. The author comes to the conclusion that it is practicable to use locomot ve tubes 18 to 20 ft. in length, and suggests that it will be important to show by careful tests the economic value of each additional foot in length beyond 16 ft. The theoretical treatment of the subject by Wökler, published in the "Bulletin of the International Railway Congress," points out the necessity of long tubes for high gas velocities, and the author thinks that it now remains to show by careful measurements on a locomotive-testing plant the value of long tubes when used with high rates of combustion. 2½ cols.—*Mach. Wrld.*, Feb. 2nd, 1900.

Expansion Engines.—*Receiver Drop in Multiple Expansion Engines.* Abstract of a paper by

Prof. R. L. Weighton, describing the result of trials made with a view to determine the most economical point of steam cut-off in the larger cylinders of multiple expansion engines. 1½ col. —*Mach. Wrld.*, Feb. 2nd, 1900.

Fast Trains.—*What does it cost to run Trains at High Speed?* Abstract of a paper by F. A. Delano, read before the Western Railway Club, U.S.A., Jan. 16th. The author believes high-speed to be very expensive. Just how expensive he is not prepared to say, but thinks it to be very advisable to study the question as being of great practical importance. 3 cols.—*Engng. News*, Jan. 25th, 1900.

Locomotive Engineering.—*Modern Locomotive Practice.* By C. E. Wolff, B.Sc. (Continued.) The author deals fully with the Engelmann-Morton principle of reversing motion and the particular cases in which this class of reversing motion is applicable. 3½ cols.—*Mech. Engr.*, Feb. 10th, 1900.

Locomotives.—*Compound Road Locomotives for the War Office.* Description of a special compound road locomotive, with cylinders side by side, destined for use in the war in South Africa. The cylinders are 7½ in. and 12 in. in diameter, and the stroke is 12 in. The indicated horse-power is 75, and it travels 6 miles an hour. (Ill.). ½ col.—*Engr.*, Jan. 26th, 1900.

—— *Friction Tests of a Locomotive Slide-Valve.* Abstract of a paper by Frank C. Wagner, read before the Am. Soc. of Mech. Engrs. Describes the results of some experiments made by the author with reference to that subject. 1¾ col.—*Mech. Wrld.*, Feb. 2nd, 1900.

2. New Projects.

3. Permanent Way and Fixtures.

Railways.—*Building the Simplon Tunnel.* By L. Frankenthal. Description of the project. The construction began on Nov. 13th, 1898, and is to be completed in 5½ years; the price to be paid is 69,500,000 francs, and the tunnel will have a length of 20 kilometers (12·4 miles). 1 col.—*Am. Mfctr.*, Feb. 1st, 1900.

Railway Signalling.—*The Laffas Patent Apparatus for Stopping Trains.* Description of an apparatus intended to bring trains automatically to a stop when the line is blocked. (Ill.) 3 cols. *Ry. Engr.*, Feb., 1900.

4. Transportation and Conducting.

Transport of Calcium Carbide.—*Calcium Carbide and its Transport throughout Germany.* Note drawing attention to the great quantities of calcium carbide imported into Germany, which made it necessary to invent a suitable form of package lessening the risk of overpressure. ½ col. *Mech. Engr.*, Jan. 6th, 1900.

5. Miscellaneous.

Railways.—*The Paris Metropolitan Railway.* Paper read by Mr. E. A. Ziffer, C.E., before the "Verein f. d. Förderung des Lokal u. Strassenbahnwesens" at Vienna, containing a detailed description of the new underground railways in Paris. (Ill.) 24 cols.—*Mittheilungen d. Ver. f. d. Förd. d. Local u. Strassenbahnw.*, Jan., 1900.

STREET AND ELECTRIC TRAMWAYS.

Electric Railways.—*Electrical Equipment of the Berlin, Germany, Elevated Railways.* The increase in traffic on the Berlin elevated railways, established 1882, has been such that steam-power is no longer able to meet it, and the "Union Elektricitäts Gesellschaft" has presented proposals to the administrator of public works for the replacement of steam traction by practically the same system of electric traction that has been so successful in Chicago, *i.e.* the Sprague system, at least as regards the main features. The estimate for the electrical equipment of the Berlin lines is £2,150,000, *i.e.* land, £52,000; buildings, £98,000; generating machinery, £300,000; motor cars, £950,000; other expenses, £76,000. The electrical service will be 28 per cent. cheaper than the steam service. 2½ cols. — *Elec. Wrld. and Engr.*, Feb. 3rd, 1900.

Tramways.—*Innovations in the Construction of Local Railways and Tramways.* Short account of the equipment of motor wagons with four motors on a tramway in California. 3 cols.—*Mittheilungen d. Ver. f. d. Förd. Local u. Strassenbahnw.*, Jan. 1900.

TRADE AND ECONOMICS.

1. Commerce and Trade.

Engineering Progress.—*The Progress of the Mechanical Arts in Three-quarters of a Century.* By Coleman Sellers, E.D. Summary of an address delivered in connection with the celebration of the seventy-fifth anniversary of the Franklin Institute, Philadelphia. (To be continued.) 3½ cols. —*Ind. and Iron*, Feb. 16th, 1900.

Exhibitions.—*Report on various Structures of the Paris Exhibition.* Detailed description of the structural peculiarities of the Palace of Machinery and the Palace of Chemical Industries, mainly drawn from articles published in "Génie Civil." 10½ cols. — *Dingler's Polyt. Journ.*, Feb. 17th, 1900.

Export Markets.—*The Finnish Machinery Market.* The author draws attention to the fact that there are many markets which would afford excellent chances to (American) exporters, but are generally overlooked. Among these he mentions the markets of Finland. 2½ cols.—*Am. Mach.*, Jan. 11th, 1900.

2. Currency and Finance.

3. Government Control.

4. Labour.

Strikes.—*Labour Disputes in 1898.* Short summary of the report of the Chief Labour Correspondent to the Board of Trade on the strikes and lock-outs in 1898. ½ col.—*Mech. Engr.*, Jan. 6th, 1900.

5. Miscellaneous.

Dyeing.—*Yorkshire College, Leeds.* Article dealing with the buildings and equipment of the College, the curriculum and course of instruction, and especially the Dyeing Department. (Ill.) 4½ cols.—*Chem. Trade Journ.*

Technology.—*The Techno-Chemical Laboratory, Bombay.* Description of the course of instruction to be followed in the Techno-Chemical Laboratory of Professor Gajjar, opened at the beginning of the present year at Girgaum. 2½ cols.—*Ind. Text. Journ.* Jan., 1900.

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NEW CATALOGUES . . .

[The Editor of FEILDEN'S MAGAZINE will be glad to consider applications for catalogues noticed on this page.]

Electric Switches, Ammeters and Voltmeters: Transformer Fuse Blocks. British Westinghouse Electric and Manufacturing Company, Ltd., Norfolk Street, London, E.C.

The above—each subject being compressed in a single handbook—are a continuation of the system of issuing catalogues adopted by the British Westinghouse Company, and referred to by us in a recent issue. We presume that in due time the Company will issue an index and binding cases. These elucidatory pamphlets—it would be a misnomer to term them catalogues—appear to us to be well worth preservation.

Electric Lighting Plant. Accumulators: Electric Accessories. The Jandus Arc Lamp. (Two Catalogues.) Drake & Gorham, Electrical Engineers, 66, Victoria Street, London, E.C.

Messrs. Drake & Gorham have been prominently associated with two important electrical specialties: the Dujardin-Planté Secondary Battery and the Jandus Arc Lamp. The Catalogue titled "Electric Lighting Plant" contains a full description of every essential to an electric lighting installation, with estimates and fixed prices. The Jandus Arc Lamp Catalogue gives a full description of this well-known appliance.

Drying Apparatus, Blowers, Heating and Ventilation. American Blower Company, 70, Gracechurch Street, London.

What is termed the "A.B.C. Fan System of Heating and Ventilation as applied to Factories, Mills, Machine Shops, &c.," is explained and illustrated.

Centrifugals, Water-driven and other: Sugar Plant. Watson, Laidlaw & Co., Dundas Street, Glasgow.

This large Catalogue (164 pp.), with complete index, is devoted chiefly to Sugar Plant, in the manufacture of which this esteemed firm have attained such a reputation.

Electric Traction Apparatus, Tramway Material, Electric Supplies, Engines, Valves, Fittings, Pipes, &c. R. W. Blackwell & Co., Ltd., 39, Victoria Street, Westminster, London, S.W.

This handsome volume bears ample testimony to the range of material dealt in by Messrs. R. W. Blackwell & Co. The book is handsomely printed and replete with illustrations. It is provided with a list, A B C index, and classified reference table, a great convenience where such a large and varied body of material is concerned.

Westinghouse Gas Engine.

The pamphlet before us, entitled "A New Industrial Situation," with an introduction by Mr. George Westinghouse, can hardly be classed under the heading of a catalogue, but as it is solely concerned with the Westinghouse Gas Engine, it approaches the character of business rather than scientific literature. Mr. Westinghouse prophesies the total abolition of the steam-engine, since, as it is asserted, "it will be too costly to maintain." It is predicted that gas will eventually supplement the employment of steam in connection with motive power. The "New Industrial Situation" will be attained when, as stated, "gas, within a short time, will be commercially produced and sold at a cost far below the lowest price that now prevails in any part of the world."

Some Notes on Automatic and Costless Sewage Lifting, &c. Adams Patent Sewage Lift Company, Ltd., York.

This well got-up little book relates chiefly to the Adams Patent Sewage Lifting System in extensive operation under various conditions in this and other countries. It besides contains information and data of a wide range of the accessories required under different sewage systems, and will be found, we think, both informative and useful to those connected with sewage matters.

Overland Freighting Outfits. O. S. Kelly Co., Springfield, Ohio, U.S.A.

Something new in traction engines is described in this pamphlet. The engine is described as an "entirely new departure from the adopted traction engine of all countries. No fly-wheel is used with the engine, mounted on top of the boiler, and a triple throw crank-shaft, with cranks 120 degrees apart, is fitted with three pairs of eccentrics." The point of cut-off is stated to be always late enough to ensure the admission of steam to two pistons, so that the starting of heavy loads is easily accomplished.

High-class Tools for Miners, Quarrymen, Contractors, and Agriculturists, &c. Hardy Patent Pick Co., Ltd., Mining Tool Works, Sheffield.

This is merely a summarising catalogue of this firm's wide range of manufactures, which comprises almost every description of plant used in connection with general mining. Separate catalogues are published of most of the Hardy Patent Pick Company's specialities, which describe them more in detail, and these, as well as the catalogue under notice, are sent to enquirers on application.

Automatic Flashing Switches for Electric Motors. William McGeoch & Co., Warwick Works, Coventry Road, Birmingham.

It is pointed out in this little *brochure* that the use of electro-motors for driving purposes is spreading with great rapidity. There is no question of the fact that this is so. Owing to the growing utilisation of the "day-load" by central stations, and the supply of cheap current in working hours when light is not required to any extent, manufacturers are availing themselves in increasing numbers of the facilities for inexpensive motor power thus brought within their reach.

Though thousands of British-made motors are in use throughout the country, starting switches, on the contrary, are to a large extent of imported make. The starting switch referred to in the book before us is constructed under Wilson's patent, and is entirely of British design and manufacture. It is stated to embody features that render it superior to imported switches, and thus, for this motive alone, should find a ready and a large sale.

Some of the World's Greatest Experts in every branch of industrial activity and scientific research are writing special articles for forthcoming issues of FEILDEN'S MAGAZINE. A wealth of other valuable matter will be published.

Leading Engineering Firms foreseeing the inevitable advance from time to time of the Advertising Rates of FEILDEN'S MAGAZINE, owing to its rapidly increasing success, are engaging space for extended periods, some for two, three, five, and even ten years, in order to avail themselves of the present Scale of Charges. It is obvious that those firms who have the enterprise to contract with the Magazine *now* will secure signal advantages.

INTERESTING ANNOUNCEMENTS

The present Annual Subscription to FEILDEN'S MAGAZINE is only **12/6**. This amount, prepaid, ensures a year's copies on the finest Art Paper—*edition de luxe*. This magnificent edition when bound forms a unique library volume. The Proprietors beg to notify that, owing to the growing pages of the Magazine and the consequent enhanced cost of production, the present subscription rate may shortly be raised; but those who become subscribers before this takes place can renew their subscriptions at the old rate. This offer is subject to withdrawal at any time if not availed of within fifteen days after publication.

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The Following Experts, among others, are contributing special articles to the next and succeeding issues of FEILDEN'S MAGAZINE:

Prof. A. C. Elliott, D.Sc., M.I.C.E.; R. B. Pollitt, A.M.I.C.E., F.C.S.; Prof. Henry Louis, A.R.S.M., F.I.C.; R. H. Thurston (New York), M.I.N.A. (Director Sibley College, Cornell University, Ithaca, New York); W. Brew, M.I.E.E.; E. C. de Segundo, A.M.I.C.E.; W. Roger Sanguinetti; J. D. Twinberrow, A.M.I.C.E.; W. H. Maxwell, A.M.I.C.E.; Anthony G. New; M. Holroyd Smith, M.I.M.E., M.I.E.E.; A. Machlachlan, A.M.I.C.E.; Major C. S. Berthon; W. Fletcher, M.I.M.E.; J. Gray Scott, A.I.E.E.; Major R. P. Davidson (U.S.A.); Dr. Carl O. Webber.

Some of the subjects to be dealt with are enumerated on p. 349 of current issue (title-page).

As Striking Evidence of the fact that FEILDEN'S MAGAZINE has become the acknowledged authority in all things pertaining to British Manufacture, the Proprietors have received thousands of press cuttings from every conceivable class of paper, from the Great Dailies downwards, quoting the expert opinions of the Magazine. A notice of anything special in the Editorial Columns of the Magazine is extensively copied in hundreds of the leading Journals throughout the world.

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THIRTY THOUSAND READERS.

From North, South, East, and West

a continual stream of tributes to "Feilden's Magazine" is flowing in. The annexed are conspicuous examples from two of Her Majesty's Ministers of Commerce.

BRITISH CONSULATE,
STETTIN.
September 16th 1899.

Sir,

I have to acknowledge receipt of your Magazine for September.

The illustrations and letterpress are far superior to those of any similar publication received at this Consulate, and the contributions are most interesting.

I shall be pleased to place it before users and buyers of machinery.

I am, Sir,
Your obedient servant,

Ralph Bernal
H.M. Consul

The Editor,
Feilden's Magazine,
Temple Chambers,
London, E.C.

BRITISH CONSULATE-GENERAL,
HAMBURG,
September 15th, 1899.

Dear Sir,

I have to thank you for your letter of the 13th inst. accompanied by a copy of issue No.2 of "Feilden's Magazine", which, so far as I can see from a mere hasty perusal, is by far the most interesting and beautifully illustrated technical magazine I have ever seen in any country. I wish the Magazine and the patriotic purpose for which it is being published every success, and shall be glad to recommend it to anybody who takes an interest in technical subjects.

Yours faithfully,
William Ford.
H. M.'s Consul-General.

The Editor of "Feilden's Magazine",
London.

Vol. I. of "Feilden's Magazine" Now ready, comprises a magnificent record of the World's Industrial Progress. It contains a mass of valuable information, together with several hundred illustrations and signed contributions by authorities in

Every branch of Industrial Activity & Scientific Research.